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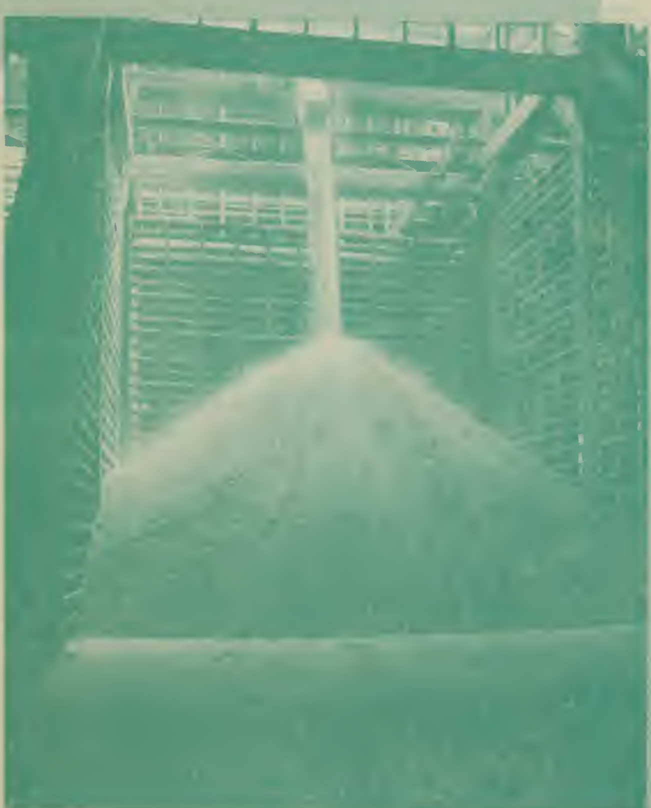
U. S. DEPARTMENT OF AGRICULTURE

MANUFACTURE OF FERTILIZER BY COOPERATIVES IN THE SOUTH



By Warren K. Trotter
FCS Bulletin 13

U.S. DEPARTMENT OF AGRICULTURE
FARMER COOPERATIVE SERVICE
WASHINGTON, D.C.

THE Farmer Cooperative Service conducts research studies and service activities of assistance to farmers in connection with cooperatives engaged in marketing farm products, purchasing farm supplies, and supplying business services. The work of the Service relates to problems of management, organization, policies, merchandising, product quality, costs, efficiency, financing, and membership.

The Service publishes the results of such studies; confers and advises with officials of farmer cooperatives; and works with educational agencies, cooperatives, and others in the dissemination of information relating to cooperative principles and practices.

Joseph G. Knapp
Administrator
Farmer Cooperative Service
U.S. Department of Agriculture

FCS Bulletin 13 **July 1959**

This is a companion study of one recently made on distribution of fertilizer by the same regional cooperatives and published as FCS Bulletin 11, *Distribution of Fertilizer by Cooperatives in the South*, October 1958.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.
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SUMMARY AND CONCLUSIONS

THIS report is based on a study of 29 cooperatives with fertilizer manufacturing facilities in the South. These cooperatives operated 42 fertilizer mixing plants, 13 phosphate rock acidulating plants, and 1 synthetic nitrogen plant.

The purposes of the study were as follows: (1) To ascertain the status of cooperatives in manufacture of fertilizer in the South; (2) to evaluate their future potential; (3) to examine implications of economic, technological, and transportation factors; and (4) to determine possibilities for further regional coordination and joint development.

For purposes of this study, the southern region was divided into three areas. Area I data cover cooperative fertilizer manufacturing plants in Maryland, Virginia, Kentucky, Tennessee, North Carolina, Georgia, and Alabama. Area II data cover plants in Mississippi, Arkansas, and Texas. Area III covers plants in Florida.

Growth of Cooperative Fertilizer Manufacture

- The first cooperative began handling fertilizer in the region in 1920. The periods of most rapid growth in number of cooperatives handling fertilizer were the depression years of the 1930's and the years immediately following World War II.
- The first cooperative plant in the South to manufacture mixed fertilizer was acquired at Chewsville, Md., in 1930. One-third of the 42 mixing plants were acquired prior to 1940, and 18 were acquired after the end of World War II.
- The main reason given for acquiring manufacturing facilities was to obtain fertilizer at a lower price. This reason was given by 85 percent of the plants included in this study.
- Major factors in locating plants in order of importance were: (1) Nearness to consumption area, (2) favorable transportation rates and facilities, (3) nearness to source of raw materials, (4) plant availability at reasonable price, and (5) labor supply and wage rates.
- About half of all fertilizer manufactured by cooperatives in the South was made in jointly owned or operated facilities of regional wholesale cooperatives. This type operation improved efficiency in the manufacture of fertilizer by making possible (1) a larger scale of operation, (2) better

trained management, (3) more highly skilled technical staffs, (4) greater bargaining power, and (5) volume buying of raw materials.

Manufacture of Mixed Fertilizer

● The 42 plants manufactured 868,000 tons of mixed fertilizer in fiscal 1956. Nearly three-fourths of this amount, or 645,000 tons, was made in Area I. Area III was second in volume with 140,000 tons, while Area II followed with 83,000 tons.

● The tonnage manufactured increased nearly one-third between 1951 and 1956. The largest proportional increase was in Area III. This area showed a gain of 56 percent compared to a 37-percent increase in Area I and a 10-percent decline in Area II.

● Over the South as a whole, cooperatives manufactured 5 percent more fertilizer than they distributed within the region in fiscal 1956. The excess of production was due primarily to shipments out of the southern region by two large cooperative manufacturers to other cooperatives.

● Production per plant in fiscal 1956 averaged about 21,000 tons. Two-thirds of all plants produced less than 20,000 tons and one-third produced less than 10,000 tons.

● The rated capacity of mixing units averaged 237 tons per 8-hour shift. Mixing capacity in Area I averaged 294 tons per shift compared to 187 tons in Area II and 154 tons in Area III.

● The fiscal 1956 output of mixed fertilizer could have been produced in 85 days of operation, 8 hours each, at rated capacity. About one-third of the plants could have produced their 1956 output in 50 days or less of operation, and two-thirds of all plants could have produced their 1956 output in 100 days or less. The output of only four plants required as much as 151 to 200 days of operation at rated capacity.

● Storage capacity for raw materials averaged 3,723 tons a plant compared to 7,692 tons for mixed goods storage. Raw materials storage was turned an average of 5.6 times during 1956, or once every 64 days. Mixed goods storage was turned 2.6 times, or once every 142 days.

● Handling of materials was accomplished by a wide variety of equipment—from two-wheeled "Georgia buggies" in some of the smaller and older plants to elaborate overhead shuttle conveyors and crane systems in the larger and more mechanized plants. Some of the small plants have not been able to keep pace with the trend toward mechanization in recent years.

● Only three plants surveyed had granulating facilities in operation at the time of the survey. However, two were in the process of installing granulating equipment and several others had rather definite plans for producing granular materials.

● Of the total tonnage of ingredients used in the manufacture of mixed fertilizer, 49.1 percent was phosphate, 19.1 percent was potash, 17.5 percent was nitrogen, 9.1 percent was secondary and trace elements, and 5.2 percent was conditioners and fillers.

● Nitrogen solution and sulfate of ammonia were the most important nitrogen materials used—accounting for 36.9 and 27.2 percent, respectively, of all tonnage of nitrogen materials.

● Normal superphosphate was by far the leading phosphate material—accounting for 93.4 percent of the total. Concentrated superphosphate followed with 3.8 percent of the total.

● Potash materials were made up chiefly of muriate of potash, which accounted for 76.4 percent of the total, and sulphate of potash-magnesium, which accounted for 11.6 percent of the total.

● The cooperatives studied used 47 sources of nitrogen materials, 27 sources of phosphate materials, and 9 sources of potash materials. In many instances sources nearer the plant could have been used with resulting savings on freight.

● Over the South as a whole, 79 percent of all inbound tonnage of ingredients used in mixed fertilizer manufacture was received by rail, 12 percent by motortruck, 4 percent by water, and 5 percent by combinations of rail and water or rail and truck.

● Rail was the most important method of transportation in all areas, accounting for from 75 to 90 percent of the total in each area. Movement by truck varied from 15.5 percent of the total in Area I to 1.5 percent in Area II.

Manufacture of Superphosphate

● Thirteen cooperative acidulating plants produced 174,600 tons of normal superphosphate in fiscal 1956. Production of this material increased by 55 percent during the period 1951–56.

● Total use of superphosphate by cooperatives, including that used in mixtures and distributed for direct application, amounted to approximately 446,000 tons. Thus, manufactured volume was equivalent to about 39 percent of total needs.

● Production of superphosphate per plant averaged 12,871 tons. If acidulating units had been operated at their rated capacity, this tonnage could have been produced in 88 days of 8 hours each. The range in days of operation at capacity required to produce the fiscal 1956 output was from 32 to 214.

● Raw material storage capacity averaged 815 tons a plant. Turnover of this capacity averaged 15.8 times in fiscal 1956. Finished product storage averaged approximately 4,800 tons a plant and was turned 2.7 times during the year.

● Cooperatives used six origin points for sulfuric acid, with the major portion of the total supply originating at Copperhill, Tenn. All phosphate rock originated in the Bartow and Tampa areas of Florida.

● Rail movement accounted for 87 percent of all raw materials received at acidulating plants. About 11.5 percent was moved by truck, while water transportation accounted for only 1.3 percent.

Manufacture of Nitrogen Materials

● The only farmer cooperative in the South producing nitrogen materials during the period covered by this study was Mississippi Chemical Corp., Yazoo City. Production of this cooperative, referred to as MCC, for fiscal 1956 included 96,100 tons of anhydrous ammonia and 143,200 tons of ammonium nitrate.

● Anhydrous ammonia production in the MCC plant was equivalent to 91 percent of all anhydrous ammonia distributed and used in manufacture by southern cooperatives. Ammonium nitrate production was equivalent to 60 percent of total cooperative needs in the South.

● MCC's plant consists of three basic sections: (1) An ammonia section, (2) a nitric acid section, and (3) an ammonium nitrate section. Designed daily capacity of these

three sections as of June 1956 was 270 tons of anhydrous ammonia, 330 tons of nitric acid, and approximately 380 tons of ammonium nitrate.

● MCC's fiscal 1956 production of anhydrous ammonia was equivalent to 98 percent of the plant's designed capacity, and production of ammonium nitrate was equivalent to 103 percent of designed capacity. All the nitric acid and a major portion of the anhydrous ammonia produced were used in the ammonium nitrate plant.

MCC has enlarged its facilities since the date of this study so that by late 1958 their capacities per 24-hour day were 310 tons of anhydrous ammonia, 450 tons of nitric acid, and 475 tons of ammonium nitrate. This cooperative also had plans to build a plant that would produce 100 tons per 24-hour day of solid urea and manufacture 50 tons of nitrogen liquid fertilizers per 8-hour day.

In 1956, MCC set up a subsidiary—Coastal Chemical Corp. It completed a plant in 1958 at Pascagoula, Miss., with the following 24-hour daily capacities: Anhydrous ammonia 150 tons, sulfuric acid 550 tons, phosphoric acid 75 tons, and high-analysis mixed fertilizers 400 tons. It also will produce the following per 8-hour day: Superphosphate 150 tons, and triple superphosphate 150 tons.

● The basic raw materials for MCC's manufacturing operations were natural gas, steam, water, and air. Natural gas was obtained by pipeline and the other materials were obtained at the Yazoo City plant site.

Conclusions

Findings in this study led to the following conclusions:

1. *Joint development and operation of facilities has been carried on with marked success in the South.*—Almost 50 percent of the nearly 1.3 million tons of mixed fertilizer and fertilizer materials manufactured by cooperatives in 1955–56 was produced in jointly owned or operated facilities. Several of these joint operations could well serve as models for further coordination of cooperative fertilizer procurement and manufacturing activities.

2. *Consolidation and modernization of some cooperative fertilizer mixing plants is desirable for the following reasons: (1) To increase operating efficiency through larger volumes, (2) to take advantage of modern technology (especially ammoniation and granulation), and (3) to modernize materials handling techniques.*—The 42 mixing plants produced an average of 20,700 tons each. On the basis of rated capacities of mixing units, this represented only eighty-five 8-hour days of operation. This is a rather low level of efficiency in the use of mixing plant facilities.

To achieve greater efficiency, consolidation of some plants is needed. Furthermore, because of the high overhead involved, some small cooperative mixing plants have not been able to keep pace with the trend toward mechanization and the newer technological developments of recent years. Modern ammoniating, granulating, conveying, and batching equipment is costly and requires large-volume operation to reduce overhead costs to satisfactory levels. Modernization of old plants is becoming increasingly urgent, and some consolidation would be desirable to spread modernization costs.

3. *Greater coordination of superphosphate procurement and manufacturing programs among cooperatives of the South appears to be needed.*—The 13 acidulating plants produced 175,000 tons of superphosphate.

This represented about 39 percent of the total of 446,000 tons distributed for direct application and used in mixtures by cooperatives of the South. Thus, approximately 271,000 tons, or 61 percent of the total needed supply, were purchased on the open market.

Indications were that existing cooperative superphosphate capacity was not utilized at the most efficient levels. Therefore, further coordination of superphosphate procurement and manufacture by southern cooperatives appears needed. The possibilities of cooperative manufacture of other phosphate materials such as concentrated superphosphate, calcium metaphosphate, and diammonium phosphate should be examined.

4. *Increased use of water transportation offers possibilities for lowering transportation costs.*—This appears especially true in the movement of phosphate rock, superphosphate, and muriate of potash. Possibilities also exist for the movement by water of ammonium nitrate, nitrogen solution, and tankage. Facilities were available or could be developed in several instances to move these materials by water, but only a small tonnage had moved this way. Where plants do not have direct access to water transportation, the possibilities for rail or truck in combination with water should be examined.

The possible advantages of water transportation are such that cooperatives should closely examine its place in their present operations and in development of future facilities. Some coordination of procurement activities may be necessary to obtain the tonnage needed for movement by water.

5. *Additional facilities for producing nitrate materials offer possibilities for further joint development by cooperatives in the South.*—Quantities of anhydrous ammonia manufactured by cooperatives were in fairly close balance with that distributed. However, the tonnage of ammonium nitrate distributed for direct application and used in mixtures far exceeded that manufactured. Likewise, considerable tonnages of nitrogen solution and sulfate of ammonia were distributed for direct application and used in mixtures by cooperatives, but neither of these materials was produced in cooperative plants. Possibilities of expanded production of nitrogen materials by cooperatives, particularly those in Areas I and III merit close study.

Manufacture of Fertilizer by Cooperatives in the South

By Warren K. Trotter[1]
Farm Supplies Branch
Purchasing Division

THE fertilizer industry in the South is characterized by rapidly changing technology and increasing costs of buildings, machinery, labor, materials, and transportation. Cooperatives and others will need to adjust to these changing conditions if they are to continue to render effective service to their farmer patrons. There is need for information on which to base plans for future development and guide efforts in making efficient use of facilities and equipment.

Purpose and Method of Study

THE purpose of this study is to present an overall view of the position of cooperatives in the manufacture of fertilizer in the South which can serve as a basis for planning future developments. Special attention is given to possible joint operations by cooperatives and others, and to the possibilities of making more efficient use of existing facilities through greater coordination of efforts. Transportation costs are taking an increasing share of the farmer's fertilizer dollar, and special emphasis is given to the impact of transportation on present and future operations.

[1] Mr. Trotter transferred to the Agricultural Marketing Service, U.S. Department of Agriculture, in the summer of 1958.

NOTE.—The author wishes to express appreciation to John R. Douglas, Jr., Division of Agricultural Relations, Tennessee Valley Authority, Knoxville, Tenn., and to John N. Mahan, Commodity Stabilization Service, U.S. Department of Agriculture for their helpful suggestions.

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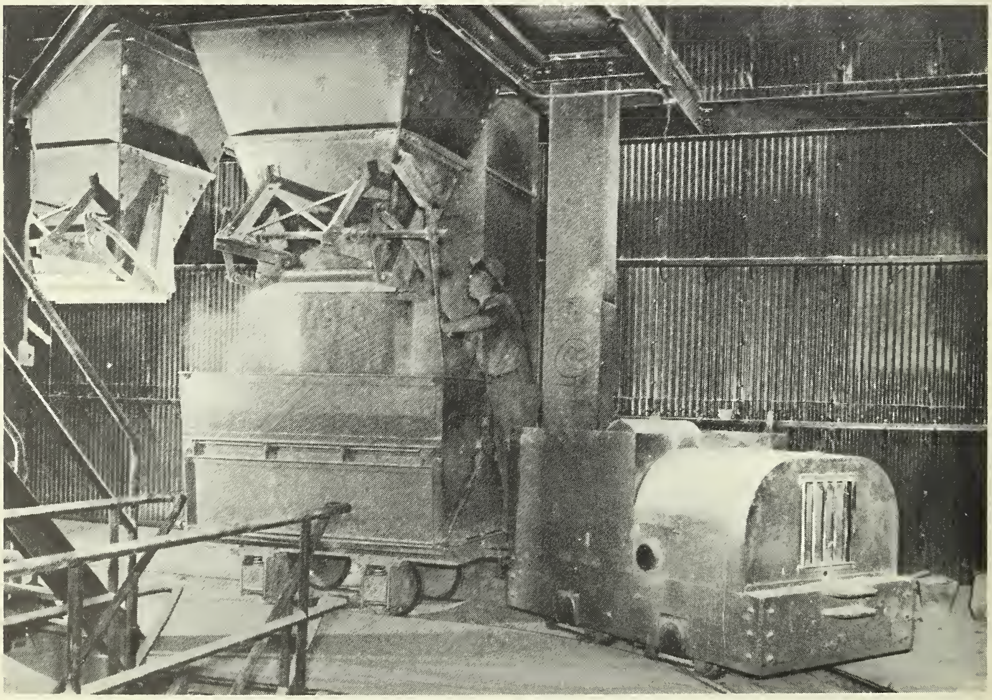
These are acidulating and mixing facilities of Tennessee Valley Cooperatives, Inc., Decatur, Ala.—one of the older fertilizer manufacturing co-ops in the South.

More specifically, the objectives of the study were to—

1. Ascertain the present status of cooperatives in the manufacture of fertilizer in the South;
2. Evaluate the future potential for cooperative manufacture of fertilizer in the region;
3. Examine the implications of economic, technological, and transportation factors on the future development of cooperative manufacturing facilities; and
4. Examine the possibilities for regional coordination in development and operation of fertilizer procurement and manufacturing facilities.

This study is based on a personal interview survey of 29 cooperatives operating fertilizer manufacturing facilities in 10 southern States. Detailed information was obtained for 1955–56 on purchases and sources of raw materials, methods of transportation used, use of raw



Fertilizer falls from chute into inplant transportation facilities in fertilizer manufacturing plant of Southern States Cooperative, Inc., Richmond. This plant is at Winchester, Ky.

materials in manufacturing operations, mixing and acidulating operations and facilities, storage facilities, and production trends. The study does not include an analysis of operating costs and net margins. Although these data are for 1955–56, the findings still directly apply to current operations.

Manufacturing operations of cooperatives in the region were divided into three categories. First was manufacture of mixed fertilizer. Of the cooperatives surveyed, 28 were engaged in this type activity, and they operated 42 fertilizer mixing plants. Second was manufacture of normal superphosphate through acidulation of finely ground rock phosphate with sulphuric acid. Ten of the cooperatives operated 13 acidulating plants for the manufacture of superphosphate. Third was the manufacture of synthetic nitrogen materials. One cooperative engaged in this activity. This report is organized around these three types of manufacturing operations.

For purposes of this analysis the South was divided into three areas to reflect differences in fertilizer use and manufacturing practices (fig. 1). Area I data cover cooperative plants in Maryland, Virginia, Kentucky, Tennessee, North Carolina, Georgia, and Alabama. Area II covers plants in Mississippi, Arkansas, and Texas. Area III covers plants in Florida.

Findings in this study should be related to those covering distribution and transportation of fertilizer by these same regional cooperatives. They were recently published as FCS Bulletin 11, *Distribution of Fertilizer by Cooperatives in the South*, October 1958.[2]

Growth of Cooperative Fertilizer Manufacturing

The first cooperative included in this study began handling fertilizer in 1922. The periods when the 29 began were as follows:

Period	*Number of associations*
1921 to 1925	3
1926 to 1930	4
1931 to 1935	7
1936 to 1940	4
1941 to 1945	3
1946 to 1950	6
1951 to 1955	2
Total	29

Acquisition of Plants

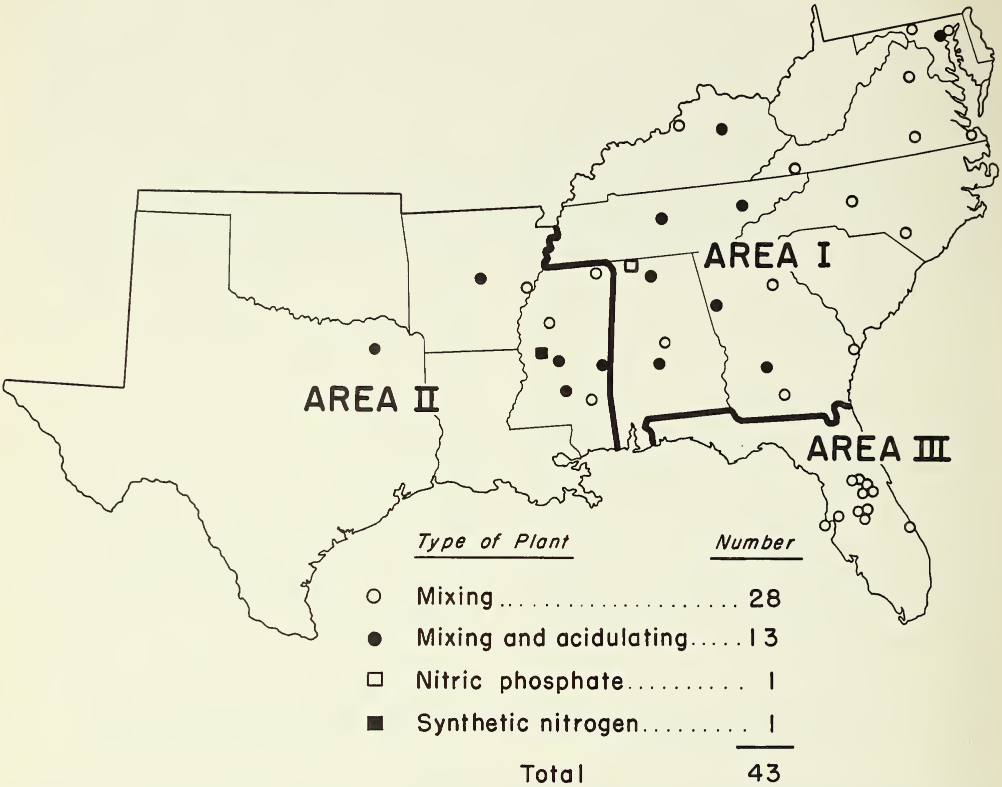
In the early days, cooperatives simply purchased a finished product and distributed it to their farmer members. After cooperatives acquired the necessary volume and capital, they believed they could make additional savings for their farmer members by acquiring their own fertilizer mixing facilities. Since superphosphate was one of the principal ingredients of mixed fertilizer, cooperatives later added acidulating plants. In recent years they have manufactured basic nitrogen materials and have acquired phosphate mineral deposits and started mining operations. Plans also call for developing their own sources of potash materials.

The first cooperative of the region to obtain a fertilizer mixing plant was the Chewsville Cooperative Association at Chewsville, Md., in 1930. Farmers Cooperative Fertilizer Purchasers, Kenbridge, Va., followed in 1932. Table 1 shows the years in which cooperative mixing plants, acidulating units, and nitrogen plants were acquired.

A little more than one-third of all

[2] The study on distribution of fertilizer covered 31 cooperatives—4 of which did not have manufacturing facilities. This study on manufacturing covers two additional cooperatives which sell their entire output to other regional associations and consequently were not included in the distribution study.

Figure 1.—Locations of cooperative fertilizer manufacturing plants covered in this study, 1956



cooperative mixing plants in the region—15—were acquired prior to 1940. Two-thirds, or 28, of the plants were acquired after 1940, and 18 of these were obtained after the end of World War II.

The Fertilizer Manufacturing Cooperative, Inc., at Baltimore,

Table 1.—Periods in which 43 cooperative fertilizer manufacturing plants in the South were acquired

Type of plant and period acquired	Area I	Area II	Area III	South
		Number		
Mixing plants:				
1926–30	1	0	0	1
1931–35	2	0	3	5
1936–40	4	2	3	9
1941–45	4	3	2	9
1946–50	4	3	2	9
1951–55	7	1	1	9
Total	22	9	11	42
Acidulating plants: [1]				
1938–45	1	0	0	1
1946–50	2	1	0	3
1951–55	5	4	0	9
Total	8	5	0	13
Nitrogen plants: 1951	0	1	0	1

[1] Each of the 13 acidulating plants is located with a mixing plant.

Md., acquired the first cooperative acidulating plant in the region in 1938. The Cotton Producers Association's plant at Cordele, Ga., followed in 1947. Of the 13 cooperative acidulating plants, 9 were acquired after 1951.

Mississippi Chemical Corp., Yazoo City, built the first cooperatively owned synthetic nitrogen plant in the United States in 1951. The pioneering efforts and outstanding success of this plant have been important factors in stimulating interest of other cooperatives in acquiring control of sources of basic fertilizer materials. Considerable progress has been made toward this end in recent years.

Reasons why cooperatives said they acquired their own manufacturing plants are given in table 2. To lower price was the principal reason mentioned by 85 percent of the 27 cooperative managers replying to this question. To obtain better quality or to have more certainty as to quality was the second most important reason. It was given by nearly one-third of the managers replying.

Location of Plants

Figure 1 shows locations of the 43 cooperative fertilizer manufacturing facilities in the Southern States. They include 28 conventional dry mixing plants, 13 plants with both mixing and acidulating operations, 1 mixing plant based on the nitric phosphate process, and 1 synthetic nitrogen plant.

If the acidulating and mixing plants were counted separately, the number of plants would be 56, with 30 plants located in Area I, 15 in Area II, and 11 in Area III.

Table 3 shows factors considered in selecting locations for cooperative fertilizer plants. The factor mentioned most frequently was the nearness of the plant to the farmers it was designed to serve—its central location in the consumption area. This was listed by 21 of the 27 replying. Favorable transportation rates and facilities were also important factors—mentioned by 11—and nearness to source of raw materials was mentioned as a consideration by 6 of those replying.

Transportation considerations, therefore, were important determinants of plant locations. Transportation must be considered both from the standpoint of finished products leaving the plant for distribution to local outlets and farmers, and also from the standpoint of incoming raw materials.

Table 2.—Reasons cooperatives acquired their own fertilizer manufacturing plants in the South, by number of associations

Reason	Area I	Area II	Area III	South	
		Number		*Number*	*Percent*
To lower prices	9	6	8	23	85
To obtain better quality or be certain of quality	4	2	2	8	30
To assure supply	0	4	0	4	15
To provide better service	2	0	2	4	15
To obtain types of mixtures needed	1	0	3	4	15
To take advantage of new process	1	0	0	1	4
To supply high-analysis fertilizer	1	0	0	1	4
Number of cooperatives responding [1]	10	7	10	27	100

[1] Do not add to total because some cooperatives gave more than one reason.

Table 3.—Major factors considered in selecting locations for cooperative fertilizer manufacturing plants in the South

Factors considered	Cooperatives	
	Number	*Percent*
Nearness to consumption area and centrally located	21	78
Favorable transportation rates and facilities	11	41
Nearness to source of raw materials	6	22
Desirable plant for sale at reasonable price	4	15
Favorable labor supply and wage rates	3	11
Availability of site	2	7
Availability of water transportation	2	2
Low power rates	1	4
Reasonable taxes	1	4
Requests of farmers in area	1	4
Site out of city limits preferred	1	4
Located with existing facilities	1	4
Number of cooperatives responding [1]	27	100

[1] Do not add to total because some cooperatives gave more than one answer.

Joint Manufacturing Programs

This report gives special attention to joint efforts of regional wholesale cooperatives in manufacturing fertilizer. In recent years, cooperatives have shown much interest in acquiring control of primary sources of supply. With control of the sources of primary materials—nitrogen, phosphate, and potash—cooperatives believe they will be in a much stronger position to serve farmers.

Such developments usually require investments beyond the means of most single cooperatives. Therefore, continued progress in improving services and lowering costs of fertilizer materials will depend more and more on coordination of efforts among local retail and regional wholesale cooperatives.

The volume of fertilizer manufactured in jointly owned or operated facilities increased from 386,000 tons during fiscal year 1951 to 627,000 tons during fiscal year 1956 (fig. 2).

The major portion of this tonnage was mixed fertilizer, which increased from 315,000 tons to 389,000 tons during the period 1951–56. Manufacture of superphosphate in jointly owned or operated facilities declined in the later years. This was due to the acquisition of acidulating plants by individual cooperatives and unfavorable sulfuric acid prices.

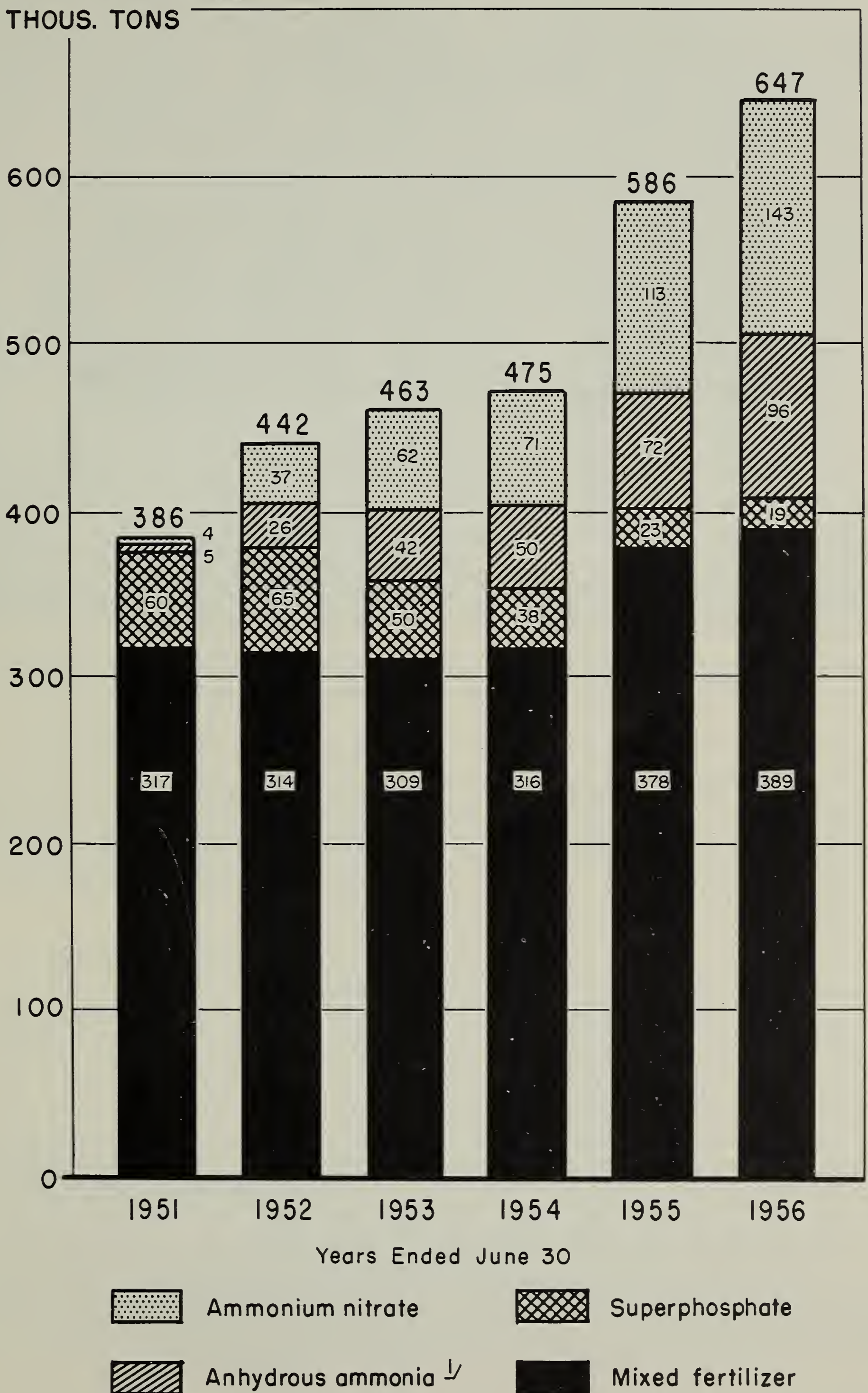
All the ammonium nitrate and anhydrous ammonia represented in this chart were manufactured by Mississippi Chemical Corp. at Yazoo City. The rapid expansion of this operation is evident from the chart.

Major efforts at joint development of facilities in the South are represented by the following organizations: (1) Associated Cooperatives, Inc., Sheffield, Ala.; (2) Cooperative Fertilizer Service, Inc., Richmond, Va.; (3) Fertilizer Manufacturing Cooperative, Inc., Baltimore, Md.; (4) Mississippi Chemical Corp., Yazoo City. Brief comments about each follow.

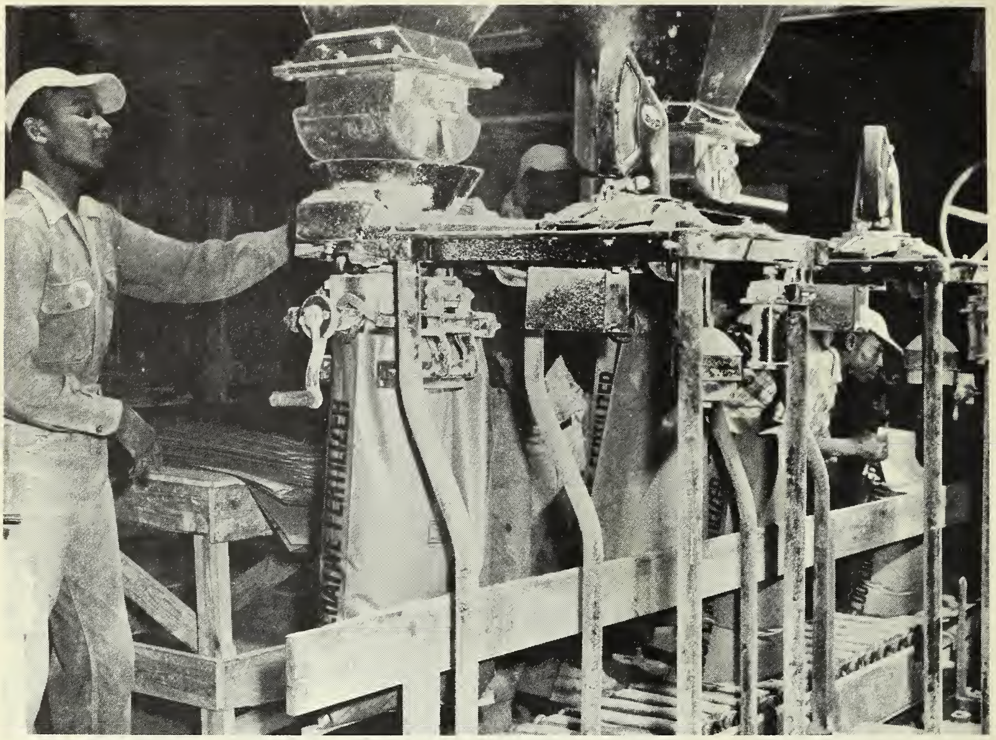
Associated Cooperatives, Inc., Sheffield, Ala.

This organization was founded in 1943 and as of June 1956 had 43 member-cooperatives with headquarters in 20 Southern, Western and Midwestern States. Some of

Figure 2.—Fertilizers manufactured in jointly owned or operated facilities of regional cooperatives in the South, years ended June 30, 1951–56



1/ Includes tonnage used in manufacturing ammonium nitrate.



Manufacturing plant, Lumberton, N.C., owned by Farmers Cooperative Exchange, Inc., Raleigh, N.C., is bagging fertilizer in 100-pound bags.

its original midwestern and western members have withdrawn to join similar groups with headquarters in Chicago and Seattle.

Associated Cooperatives has had contractual relations with Tennessee Valley Authority (TVA) since 1943 and with other fertilizer manufacturers from time to time. Before 1954 its main function was the purchase for its members of fertilizer materials, including ammonium nitrate, concentrated superphosphate, muriate of potash, and calcium metaphosphate.

In 1954, Associated Cooperatives built a fertilizer plant based on a new nitric phosphate process developed by TVA. The plant has produced granulated 14–14–14 and 15–15–15 complete fertilizers in a continuous process and plans to add other grades. The process is based on the use of nitric and phosphoric acid for acidulation of ground rock phosphate. It results in a granulated product, completely water soluble and ready for distribution without the need for a curing period.

Cooperative Fertilizer Service, Richmond, Va.

This organization is the fertilizer manufacturing arm of Southern States Cooperative, Inc., Richmond, Va.; Pennsylvania Farm Bureau Cooperative Association, Harrisburg; and Farmers Cooperative Exchange, Raleigh, N.C. Its headquarters are in Richmond, Va., and at the time of this survey the organization operated seven plants located in Maryland, Virginia, Kentucky, and North Carolina. In 1957, Southern States Cooperative, Inc., acquired an additional plant in Virginia, which was placed under supervision of Cooperative Fertilizer Service.

This organization provides expert management and technical know-how for operation of its affiliates' fertilizer plants. Joint effort of this type makes possible economies of volume buying of raw materials and exercise of mass bargaining power in the market place.

Of the plants operated by this organization, three were wholly owned by Southern States Cooperative, Inc., and two by Farmers Cooperative Exchange; one was jointly owned by Southern States Cooperative, Inc., and Pennsylvania Farm Bureau Cooperative Association; and one was jointly owned by Southern States Cooperative, Inc., and Farmers Cooperative Exchange.

For purposes of ownership and distribution of net margins, Cooperative Fertilizer Service is incorporated under three separate charters. These are known as Cooperative Fertilizer Service, Inc., of Baltimore; Cooperative Fertilizer Service, Inc., of Richmond; and Cooperative Fertilizer Service, Inc., of Norfolk. The first is jointly owned by Southern States Cooperative, Inc., and Pennsylvania Farm Bureau Cooperative Association. The second is wholly owned by Southern States Cooperative, Inc., and the third is jointly owned by Southern States Cooperative, Inc., and Farmers Cooperative Exchange.

Fertilizer Manufacturing Cooperative, Inc., Baltimore, Md.

In 1932, the Cooperative G.L.F. Exchange, Ithaca, N.Y., rented a fertilizer plant in Baltimore to manufacture mixed fertilizer for its affiliates in New Jersey, Pennsylvania, and New York. Baltimore was selected to take advantage of water transportation. G.L.F. operated the plant on a rented basis until January 1, 1938. On that date G.L.F. and The Farm Bureau Cooperative Association, Inc., Columbus, Ohio, formed the Fertilizer Manufacturing Cooperative, Inc., which purchased the plant.

In January 1943, Southern States Cooperative, Inc., and Pennsylvania Farm Bureau Cooperative Association acquired an interest in the plant. The ownership as of May 1, 1956, was divided approximately as follows: G.L.F., 53 percent; Pennsylvania Farm Bureau Cooperative Association, 26 percent; The Farm Bureau Cooperative Association, Inc. (Ohio), 18 percent; and Southern States Cooperative, Inc., 3 percent.

Fertilizer manufacturing plant of Associated Cooperatives, Sheffield, Ala. Tank trailer in foreground, used to transport the raw materials nitric acid and phosphoric acid, is built of stainless steel. Storage tanks, left foreground, hold anhydrous ammonia which tank cars, left center, transport away from the plant. Boxcars are loaded with manufactured products. They obscure the plant's loading dock.

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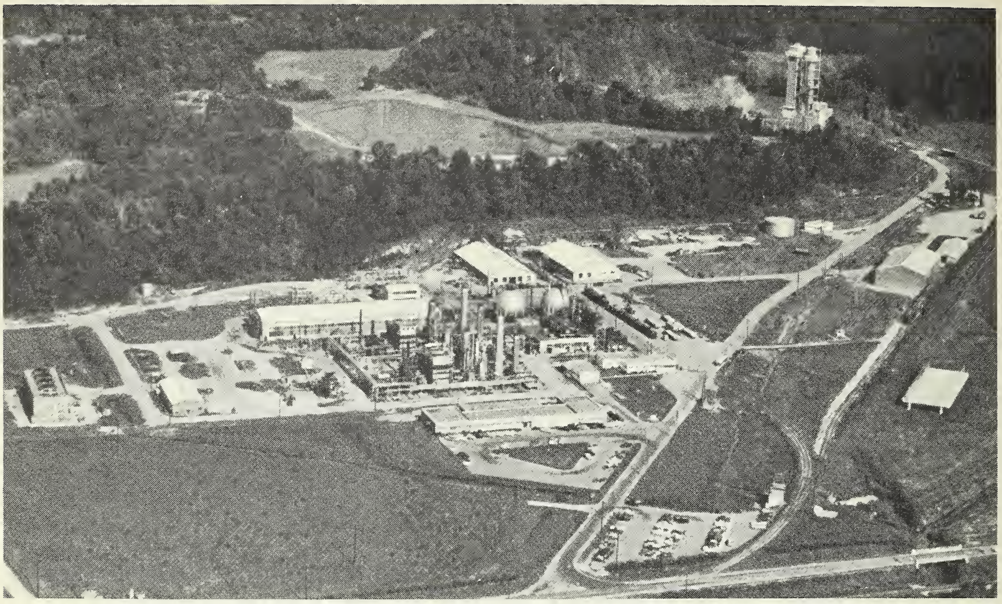

Ten thousand southern farmers own Mississippi Chemical Corp.'s nitrogen fertilizer plant at Yazoo City, Miss. This is the first farmer-owned plant supplying a basic fertilizer material. In the foreground is the ammonia plant. The towers in the right background are the ammonium nitrate fertilizer prilling towers.

Plant production for 1956 was distributed approximately as follows: G.L.F., 40 percent; Pennsylvania Farm Bureau Cooperative Association, 50 percent; The Farm Bureau Cooperative Association, Inc. (Ohio), none; and Southern States Cooperative, Inc., 10 percent.

Shipments were made direct to retail outlets of the member regional cooperatives, and billing was handled through the regionals. Net margins or overcharges were distributed at the end of the year on a patronage basis.

The plant's capacity is approximately 80,000 tons of mixtures and 40,000 tons of superphosphate a year. In 1955, continuous ammoniating and granulating equipment was installed based on latest process research by TVA.

Mississippi Chemical Corp., Yazoo City

Mississippi Chemical Corp. was organized in 1948 to supply nitrogenous fertilizer to farmers who could not at that time obtain their needs elsewhere. Its anhydrous ammonia and ammonium nitrate plants were completed in June 1951. Through its fiscal year ended June 30, 1956, the plant had produced approximately 290,000 tons of anhydrous ammonia and 430,000 tons of ammonium nitrate.[3] Total dividends and patronage refunds paid to stockholders during 5 years of operation between 1951 and 1956 totaled about $9.2 million.

On June 30, 1956, the association had 9,667 farmers and 63 coopera-

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[3] Through the organization's fiscal year ended June 30, 1958, it had produced 480,000 tons of anhydrous ammonia and 760,000 tons of ammonium nitrate. Total dividends and patronage refunds paid to stockholders during 7 years of operation between 1951 and 1958 totaled about $17 million. On June 30, 1958, the corporation had 9,144 farmers and 84 cooperatives as stockholders. Cash invested in the organization totaled about $11 million and its assets amounted to some $18 million.

The organization allocated fertilizer to members in 1957–58 on the basis of 1 ton of ammonium nitrate for each $50 of stock and 1 ton of anhydrous ammonia for each $90 of stock.

tives as stockholders. Cash invested in the organization amounted to about $11 million, and its assets as of June 30, 1956, amounted to some $18 million.

The organization allocated its fertilizer to members on the basis of stock ownership. The 1955–56 allocation was on the basis of 1 ton of ammonium nitrate for each $75 of stock and 1 ton of anhydrous ammonia for each $100 of stock.

Mississippi Chemical Corp. sponsored Coastal Chemical Corp., which was organized as a subsidiary in March 1956. The charter of the latter company provided that control stock would be owned by Mississippi Chemical Corp. and that the latter would provide management.

Coastal Chemical Corp.'s facilities are located at Pascagoula, Miss., and include sulfuric and phosphoric acid plants, superphosphate and treble superphosphate plants, a high-analysis fertilizer plant, and a synthetic nitrogen plant. Production from these facilities was allocated on the basis of stock ownership as in the case of the parent company.

These four organizations—Associated Cooperatives, Inc., Sheffield, Ala.; Cooperative Fertilizer Service, Richmond, Va.; Fertilizer Manufacturing Cooperative, Inc., Baltimore, Md.; and Mississippi Chemical Corp., Yazoo City—are examples of joint action by regional wholesale farm supply associations. The first was set up primarily as a procurement agency for its members. Because of the financial strength developed by this joint activity, the organization was able to take advantage of a new process developed by TVA. This venture would have been too great a risk for one organization to assume alone.

The second organization is an example of how efficiency of operation can be improved by joint action. The expert management, highly trained technical staff, and volume buying power of this organization could not be achieved to the degree it has been without the coordination of efforts of several associations.

The third organization was a pioneering attempt at regional development. It was started to achieve economies through large-scale manufacturing operations and to lower transportation costs through the use of water transportation.

The fourth organization is an outstanding example of joint action by both local and regional cooperatives and individual farmers who pooled their capital resources in order to provide for themselves basic fertilizer materials. Without this pooling of resources, the heavy investment required in facilities to manufacture synthetic nitrogen would not have been possible.

This is the versatile lift hopper truck used extensively in cooperative fertilizer manufacturing plants. This one is in the Canton, Miss., plant of Mississippi Federated Cooperatives (AAL), Jackson.

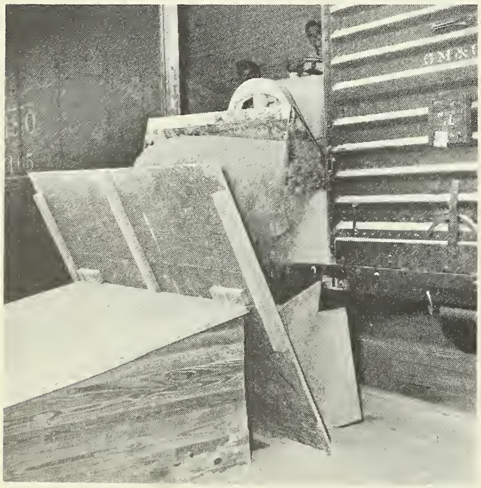
Manufacture of Mixed Fertilizer

MIXED fertilizer was manufactured by 29 of the cooperatives in 42 fertilizer plants. This cooperative activity will be examined under the following headings: (1) Production trends, (2) facilities and operations, (3) ingredients used, (4) seasonality in use of ingredients, (5) origin of ingredients, and (6) transportation of ingredients.

Production Trends

The 42 plants manufactured 868,000 tons of mixed fertilizer in fiscal 1956 (fig. 3). Nearly three-fourths of this amount, or 645,000 tons, was made in Area I. Area III was second in volume with 140,000 tons, while Area II followed with 83,000 tons.

Mixed fertilizer tonnage increased nearly one-third during the period 1951–56. It was 868,000 tons in fiscal 1956 compared with 653,000 tons in 1951. The largest proportional increase was in Area III, which showed a gain of 56 percent. Area I had a 37-percent increase, and Area II showed a 10-percent decline.



A payloader unloads fertilizer ingredients from boxcar for plant manufacture in Southern States Cooperative's plant at Louisville, Ky.

The tonnage of mixed fertilizer manufactured by cooperatives is compared with the volume distributed by cooperatives in table 4. Over the South as a whole, cooperatives produced 5 percent more fertilizer than they distributed within the region in 1956. The excess was due primarily to shipments out of the southern region by two large cooperative manufacturers to other cooperatives. The excess also may have resulted from having a carryover to the 1957 fertilizer year. However, this was a relatively small volume since carryover by one association helped cancel shortages of other associations. Some plants manufacture more in a given year than they distribute, while others distribute more than they manufacture and thus use up carryover from previous years. Generally, however, manufacturing is geared so closely to distribution that there is a minimum of carryover from year to year.

There was considerable variation between areas, however. Area I cooperatives had a net excess of about 17 percent in manufactured volume. Area II had a deficit of 39 percent, while in Area III manufactured volume was in close balance with distributed volume.

Area I had an excess of manufactured volume because two cooperatives in the area shipped considerable tonnage for distribution outside of the South. On the other hand, Area II data cover two cooperatives that distributed considerable quantities of fertilizer, but had no manufacturing facilities. These two cooperatives purchased their fertilizer from private manufacturers.

Cooperative distribution of fertilizer in Area II in recent years has expanded somewhat more rapidly

Figure 3.—Mixed fertilizers manufactured in 42 cooperative fertilizer plants in three areas of the South, years ended June 30, 1951–56

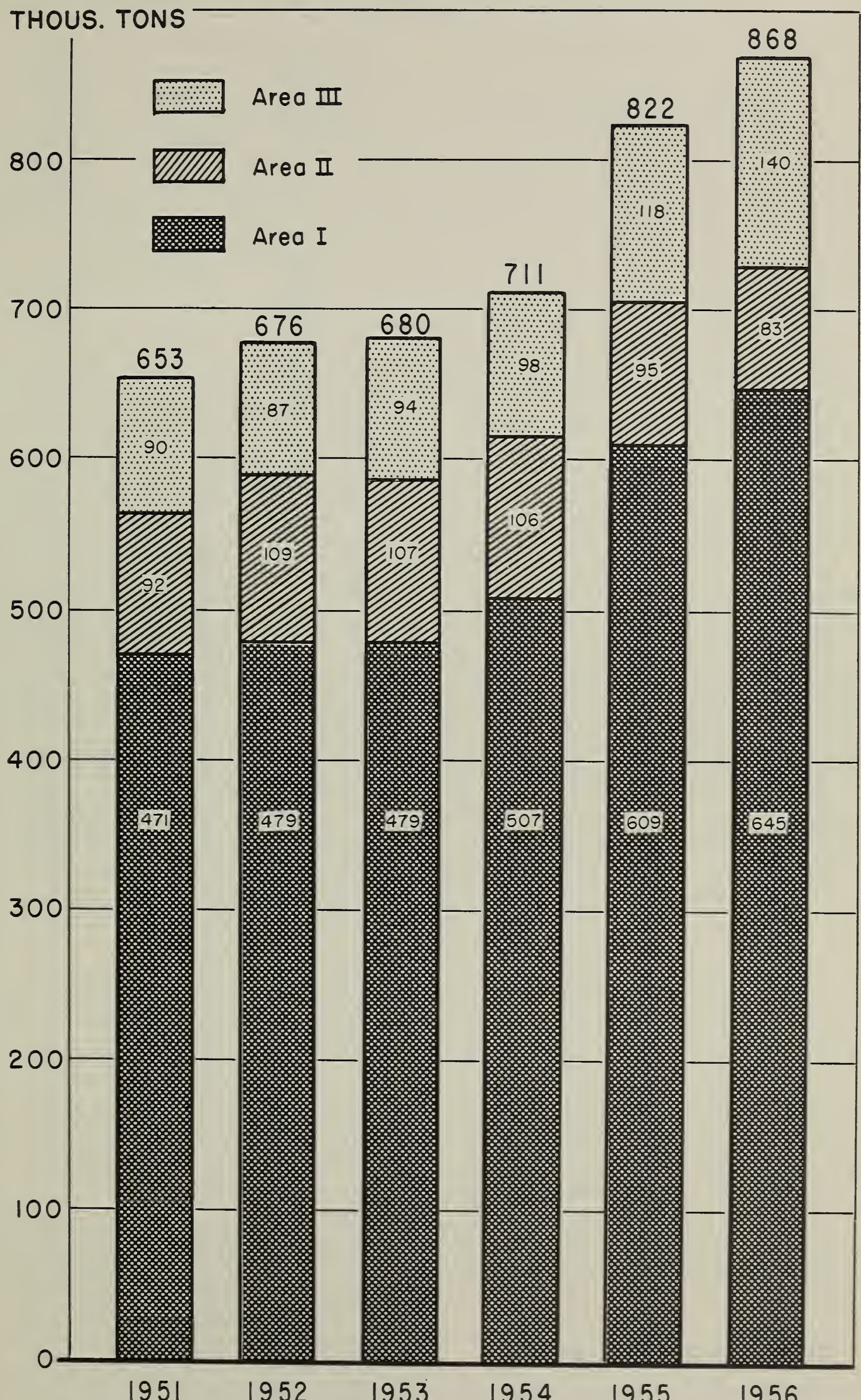


Table 4.—Relationship of mixed fertilizer tonnage distributed by 31 cooperatives in the South to that manufactured in their 42 mixing plants, 1951–56

Area and years ended June 30	Mixtures distributed	Mixtures manufactured	Volume manufactured as percentage of volume distributed
	1,000 tons	*1,000 tons*	*Percent*
Area I:			
1951	390	471	121
1952	426	479	112
1953	437	479	110
1954	451	507	112
1955	535	609	114
1956	553	645	117
Area II:			
1951	109	92	84
1952	120	110	92
1953	123	107	87
1954	121	106	88
1955	117	95	81
1956	137	83	61
Area III:			
1951	90	90	100
1952	87	87	100
1953	94	94	100
1954	99	98	99
1955	117	118	101
1956	137	140	102
South:			
1951	589	653	111
1952	633	676	107
1953	654	680	104
1954	671	711	106
1955	769	822	107
1956	827	868	105

than cooperative manufactured volume, while the reverse was true in Areas I and III.

These data indicate a possibility for cooperatives in Area II to make additional savings for their farmer members by manufacturing additional quantities of mixed fertilizer. This need has already been recognized and one of the cooperatives has constructed a high-analysis mixed fertilizer plant at Pascagoula, Miss.

Facilities and Operations

In general, the manufacture of mixed fertilizer is relatively simple. The process consists essentially of weighing and mixing several ingredients in their proper proportion and then bagging the resulting products.[4] Most of the ingredient materials are dry with the exception of nitrogen solution which has become the principal source of nitrogen in recent years.

[4] A detailed discussion of steps in the manufacture of mixed fertilizer is carried in Grab, Eugene G., Hurst, Wilbur M., and Scroggs, Claud L. *Cooperative Fertilizer Plants*, Circular C–145, Farm Credit Administration, U.S. Department of Agriculture, May 1952. This publication is no longer available from the U.S. Department of Agriculture, but may be found in land-grant college libraries.

Table 5.—Frequency distribution of size and type mixer operated by 35 cooperative fertilizer plants, 1956

Size and type mixer	Area I	Area II	Area III	South
		Number of plants		
½-ton batch	1	2	3	6
1-ton batch	6	4	2	12
1½-ton batch	4	1	2	7
2-ton batch	7	0	1	8
Continuous drum	1	1	0	2
Total	19	8	8	35

Mixing Units

The activity in a mixed fertilizer plant is centered around the mixing unit. Of 35 cooperative plants on which detailed information was available, 33 used a rotary-drum, batch-type mixing unit. With this unit, ingredient materials are put into the drum through a door which also discharges the finished product.

The two other plants used a continuous drum mixing unit. In both instances this type was used to produce granular fertilizer. Incoming materials were continuously fed into the drum from one end and discharged from the other end.

Capacities.—The 1-ton batch mixing unit was the most common size used. Of the 33 plants having batch mixers, 12 used this size (table 5). Eight plants used a 2-ton batch mixer, seven used a 1½-ton size, and six used a ½-ton size.

Table 6 gives the rated capacities of mixing units per 8-hour shift. Twelve plants fell into the category of 101 to 200 tons per shift. This capacity unit corresponds to the 1-ton batch mixing unit.

Capacity of mixing units was higher in Area I than in either Area II or III. Mixing capacities in Area I averaged 294 tons per 8-hour shift compared to 187 tons in Area II and 154 tons in Area III. For the South as a whole, cooperative plants averaged 237 tons per 8-hour shift.

Total production of the 35 plants was 710,000 tons in 1956 (table 7). This was an average of approximately 21,000 tons a plant. The 19 plants located in Area I produced

Table 6.—Frequency distribution of mixing capacity per 8-hour shift of 35 cooperative fertilizer plants, 1956

Mixing capacity per 8-hour shift	Area I	Area II	Area III	South
		Number of plants		
100 tons or less	1	2	3	6
101 to 200 tons	5	4	3	12
201 to 300 tons	5	1	2	8
301 to 400 tons	5	1	0	6
Over 400 tons	3	0	0	3
Total	19	8	8	35
		Tons		
Average capacity	294	187	154	237

Table 7.—Frequency distribution of tons of mixed fertilizer produced by 35 cooperative fertilizer plants, 1956

Tons produce	Area I	Area II	Area III	South
	Number of plants			
5,000 or less	1	2	3	6
5,001 to 10,000	1	3	2	6
10,001 to 15,000	5	0	0	5
15,001 to 20,000	4	2	2	8
20,001 to 25,000	1	1	0	2
25,001 to 30,000	1	0	1	2
Over 30,000	6	0	0	6
Total	19	8	8	35
	Tons			
Total volume	547, 123	82, 258	81, 027	710, 408
Average volume	28, 796	10, 282	10, 128	20, 894

547,000 tons, or an average of approximately 29,000 tons. Eight plants in Area II produced 82,000 tons, or approximately 10,000 tons a plant. And eight plants in Area III produced approximately 81,000 tons, also averaging about 10,000 tons.

Of the 35 plants, 25 produced less than 20,000 tons and 12 produced 10,000 tons or less. Thus about one-third of all plants produced 10,000 tons or less in 1956.

Operating Efficiency.—Table 8 shows the number of days of operation at rated capacity required to produce the total annual output of the 35 cooperative plants for fiscal 1956. Over the South as a whole, 13 of the plants could have produced their total annual output that year in 50 days or less of operation. Twenty-five of the 35 plants could have produced their 1956 output in 100 days or less. The output of only four plants required as much as 151 to 200 days of operation of the mixing unit at its rated capacity.

Plant capacities were utilized more fully in Area I than in either Area II or III. The output of

Table 8.—Frequency distribution of number of days of operation at rated capacity required to produce the annual output of 35 cooperative fertilizer plants, 1956 [1]

Days of operation required	Area I	Area II	Area III	South
	Number of plants			
50 or less	4	5	4	13
51 to 100	8	1	3	12
101 to 150	4	1	1	6
151 to 200	3	1	0	4
Total	19	8	8	35
	Days			
Average number of days [1]	98	55	66	85

[1] Based on managers' estimates of fertilizer mixing capacity per 8–hour day.

plants in Area I required 98 days of operation at rated capacity. This compared with 66 days in Area III and only 55 days in Area II.

It is usual for fertilizer mixing plants to have excess annual capacity because of the highly seasonal nature of the fertilizer business. Because most fertilizer is used in a relatively short period during the year, it is essential that plants be able to produce a large volume just preceding and during this relatively short period.

Annual output depends on several factors in addition to capacity of the mixing unit. The most important of these are (1) length of the fertilizer season, (2) number of producing seasons, (3) how well the manufacturing operations can be synchronized with distribution of fertilizer, and (4) storage capacity for mixed fertilizer at the plant.

If the season for using fertilizer is relatively long, the plant can operate over a longer period without filling up its storage capacity. Nevertheless, the wide variation in days required to produce the annual output indicated that some of the cooperative plants were not utilized at satisfactory levels of efficiency. Since each of 10 plants operated 100 days or more in 1956, this level of operation could be established as a goal for the other 25 plants. To achieve this modest level of operating efficiency, however, some consolidation of plants may be necessary.

Storage Capacity and Turnover

Most of the floor space in a fertilizer plant is used as storage for raw materials and mixed goods. Because of high construction costs, it is essential that cooperatives made the most efficient use possible of their storage space. Storage space in fertilizer plants is usually

Table 9. Frequency distribution of tons of storage capacity for raw materials and mixed goods for 35 cooperative fertilizer plants, 1956

Tons of storage capacity [1]	Area I	Area II	Area III	South
Raw materials:		*Number of plants*		
500 or less	3	2	0	5
501 to 2,000	8	0	3	11
2,001 to 4,000	2	1	3	6
4,001 to 6,000	2	2	1	5
Over 6,000	4	3	1	8
Total	19	8	8	35
		Tons		
Average storage capacity	3, 682	5, 450	2, 094	3, 723
Mixed goods:		*Number of plants*		
1,000 or less	2	1	8	11
1,001 to 5,000	3	1	0	4
5,001 to 10,000	9	1	0	10
10,001 to 15,000	2	4	0	6
15,001 to 20,000	1	0	0	1
Over 20,000	2	1	0	3
Total	19	8	8	35
		Tons		
Average storage capacity	9, 368	11, 250	152	7, 692

[1] Includes both bulk and bagged storage. Superphosphate storage of acidulating plants was included in the raw materials storage of mixing plants.

allocated between raw materials and mixed goods, although there may be some shifting back and forth between assigned areas from time to time.

Raw Materials Storage.—The 35 cooperative plants studied in detail had an average of 3,723 tons of raw materials storage in 1956 (table 9). Nearly half the plants had less than 2,000 tons, while eight plants had over 6,000 tons allocated to raw materials.

Average raw materials storage capacity varied considerably in the three areas of the South. Area I plants averaged approximately 3,682 tons of storage compared to about 5,450 tons in Area II and 2,094 tons in Area III.

Mixed Goods Storage.—In general, space allocated to mixed goods storage was about twice that allocated to raw materials storage. The average mixed goods storage for the 35 cooperative plants was 7,692 tons compared to 3,723 tons for raw materials. The variation among plants was much greater in mixed goods storage than in raw materials storage. Eleven plants, or nearly one-third of all those studied in detail, had less than 1,000 tons of mixed goods storage. Three plants, on the other hand, had more than 20,000 tons of mixed goods storage.

The mixed goods storage capacities of plants in Area II were largest, averaging approximately 11,200 tons a plant. This compared with about 9,400 tons a plant in Area I and only 152 tons a plant in Area III.

The relatively little storage space allocated to mixed goods in Area III was due to differences in seasonality and fertilizer distribution practices in this area. Fertilizer use is less seasonal because of the long growing season and variety of crops grown. Much of the fertilizer is bulk-spread direct from the mixer. Thus there is little need for storage space for curing fertilizer because it is used direct from the mixer without having gone through a curing stage.

Nitrogen Solution Storage.—Table 10 shows provisions made by 35 cooperatives for storing nitrogen solution. Ten plants had their own storage facilities for solution, 18 used solution direct from railway tank cars, and 7 did not use nitrogen solution in their manufacturing operations. The average amount of solution storage for the 10 plants having such facilities was 86 tons.

Table 10.—Frequency distribution of provisions made for storing or using nitrogen solution in mixing operations by 35 cooperative fertilizer plants, 1956

Provisions made	Area I	Area II	Area III	South
		Number of plants		
Have own storage tanks with capacities of—				
100 tons or less	5	3	0	8
101 to 200 tons	0	1	0	1
Over 200 tons	0	1	0	1
Use direct from tank cars	13	2	3	18
Don't use at all	1	1	5	7
Total	19	8	8	35
		Tons		
Average storage capacity [1]	63	109	0	86

[1] Includes only those plants having storage capacity.

Table 11.—Frequency distribution of days of operation at rated capacity allowed for in raw materials and mixed goods storage capacity by 35 cooperative fertilizer plants, 1956

Days of operation allowed for in storage capacity	Area I	Area II	Area III	South
		Number of plants		
Raw materials:				
5 or less	5	2	1	8
6 to 10	7	0	1	8
11 to 15	0	1	3	4
16 to 20	5	2	2	9
21 to 25	0	1	1	2
Over 25	2	2	0	4
Total	19	8	8	35
		Days		
Average days of operation	13	29	14	16
		Number of plants		
Mixed goods:				
10 or less	1	1	8	10
11 to 20	4	1	0	5
21 to 30	4	0	0	4
31 to 40	6	0	0	6
41 to 50	3	0	0	3
51 to 60	1	3	0	4
61 to 70	0	1	0	1
Over 70	0	2	0	2
Total	19	8	8	35
		Days		
Average days of operation	32	60	1	32

Mixing Capacity Related to Storage Capacity.—Uncertainty in supplies and delays in transportation often make the relationship of raw materials storage capacity to mixing capacity an important consideration. By the same token, the highly seasonal nature of fertilizer use makes the relationship of mixed goods storage capacity to mixing capacity significant in fertilizer plant operations. These relationships can be expressed in terms of the number of days the plant could operate without replenishing its supplies of raw materials or shipping out mixed goods. These data computed by dividing storage capacity by the rated capacity of the mixing unit per 8-hour shift, are presented in table 11.

On the average, cooperative plants in the South had the equivalent of 16 days of operation at capacity in *raw materials storage*. In other words, these plants on the average could operate 16 days without having to replenish their supply of raw materials. About one-fourth of the plants could store only a 5-day-or-less supply of raw materials, while six plants fell in the "over 25 days" category. In Area I, raw materials storage capacity was equivalent to 13 days of operation at rated capacity. This compared with 29 days in Area II and 14 days in Area III.

These data show that a dependable source of raw materials is an important factor in efficient operation of a fertilizer mixing plant. This is one reason why cooperatives in recent years have been interested in gaining control of their primary sources of supply.

Mixed goods storage at the 35 cooperative fertilizer plants studied in detail was equivalent, on the average, to 32 days of operation. However, there was a wide variation among the 35 plants. Ten plants had the equivalent of 10 days or less of operation in mixed goods storage, whereas two plants had over 70 days.

Mixed goods storage in relation to plant capacity varied widely between areas. Plants in Area III on the average had the equivalent of only 1 day of operation in mixed goods storage. This compared with 32 days in Area I and 60 days in Area II. Again the situation in Area III was largely due to the less seasonal nature of the fertilizer business in that area, and to the fact that most of the fertilizer was used direct from the mixer without having to go through a curing stage.

Turnover in Storage Capacity.—The turnover in storage capacity for the fiscal year 1956, calculated by dividing 1956 output by tonnage of raw material and mixed goods storage capacity, is shown in table 12.

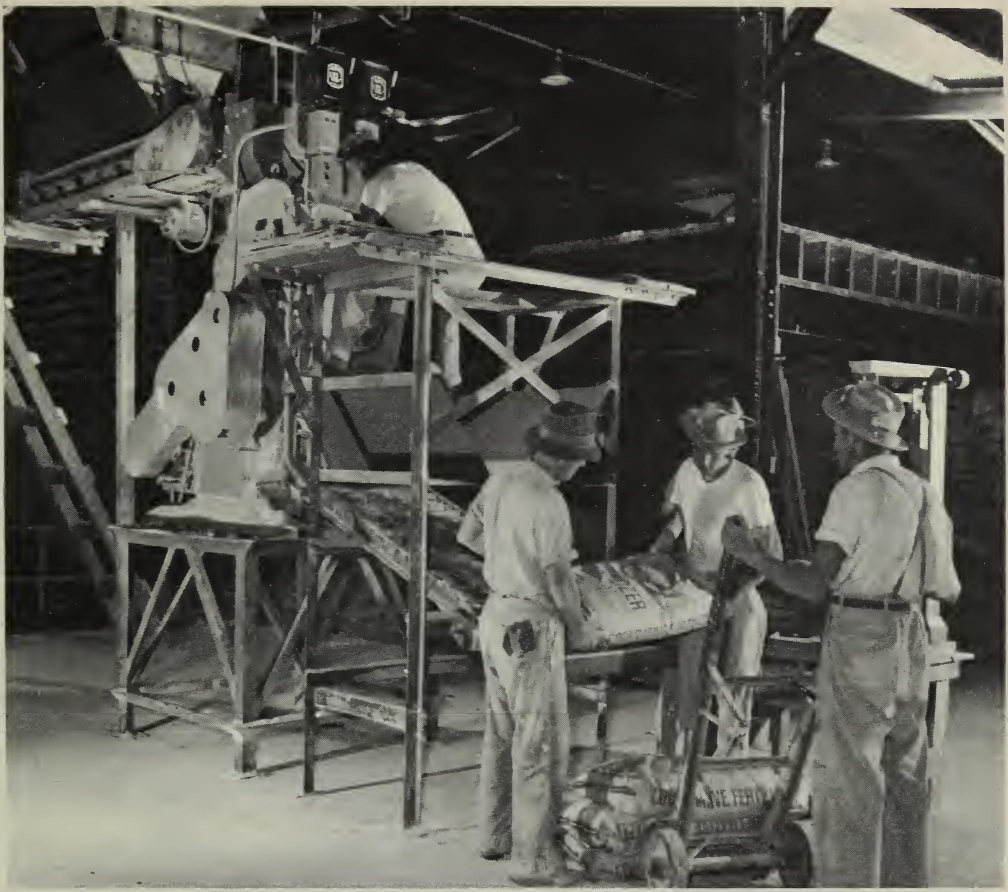
Raw material storage in the 35 plants was turned an average of 5.6 times during 1956. In other words, supplies of raw materials were depleted and replenished an average of 5.6 times during the year, or once every 64 days. There was a wide variation in turnover among the 35 plants, however, as seen by the fact that 16 plants had a turnover of 5 times or less while 1 plant averaged better than 30 times.

The variation was great between areas, also. Plants in Area I turned their raw materials an average of 7.8 times, or approximately once every 45 days. This compared with about 2 times in Area II and 5 times in Area III. This indicates that plants in Area I used their raw materials storage capacity more efficiently than plants in either Area II or III.

Mixed goods storage was turned an average of 2.6 times or once

Table 12.—Frequency distribution of turnover of raw material and mixed goods storage capacities for 35 cooperative fertilizer plants, 1956

Turnover	Area I	Area II	Area III	South
Raw materials:		*Number of plants*		
5 or less	4	7	5	16
5.1 to 10.0	6	0	2	8
10.1 to 15.0	3	1	1	5
15.1 to 20.0	3	0	0	3
20.1 to 25.0	1	0	0	1
25.1 to 30.0	1	0	0	1
Over 30	1	0	0	1
Total	19	8	8	35
		Times		
Average turnover	7.8	1.9	4.8	5.6
Mixed goods:		*Number of plants*		
1.0 or less	0	4	0	4
1.1 to 2	5	3	0	8
2.1 to 3	7	1	0	8
3.1 to 4	2	0	0	2
4.1 to 5	2	0	0	2
Over 5	3	0	8	11
Total	19	8	8	35
		Times		
Average turnover	2.8	0.9	66.7	2.6



Bags of fertilizer move from valve packing unit in manufacturing plant of Southern States Cooperative, Inc., at Winchester, Ky.

every 142 days. However, there was a wide variation among plants and among areas. Four plants turned their mixed goods storage space less than 1 time during the year, while 11 plants had a turnover of more than 5 times.

The variation between areas was highly significant. Area I plants had an average turnover of 2.8 times which could be considered about normal. Plants of Area II, on the other hand, had a turnover of slightly less than 1 time. This meant that storage capacity for mixed goods in Area II was somewhat greater than their combined output for 1956. Average turnover for mixed goods storage in Area III was extremely high—about 67 times. This again is a reflection of the seasonal and fertilizer use practices of that area.

Materials Handling

Materials handling is a major operation in manufacturing mixed fertilizer. Probably no other operation in the fertilizer mixing plant requires as much machinery, equipment, and man-hours as that of moving materials from one point to another within the plant. Efficient handling equipment, well-organized work methods, and good plant layout, therefore, are major determinants of plant operating efficiency.

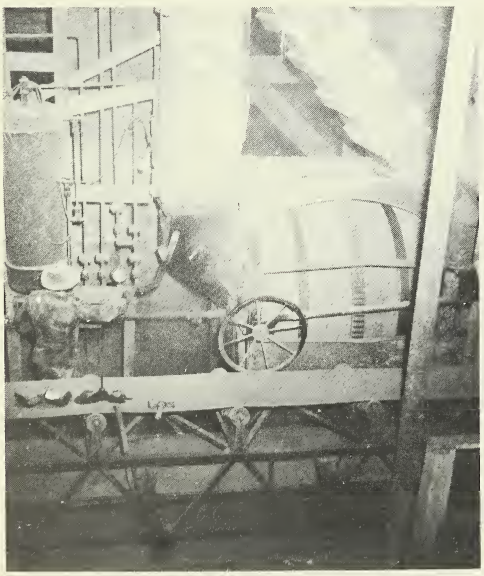
Materials are generally handled several times before they become a finished product. They generally are unloaded from rail cars or

trucks; moved into the plant, to and from storage bins, scales, mixing unit, curing bins, crusher or pulverizer, bagging unit, sizing screens, and the like, then moved to loading docks, and finally loaded on trucks or freight cars for distribution to retail outlets or farmers.

To do this tremendous handling job a wide variety of equipment is used—from two-wheeled "Georgia buggies" in some of the smaller and older plants to elaborate overhead shuttle conveyors and crane systems in the larger and more mechanized plants.

The lift-hopper truck, commonly referred to as the "payloader," was used by all cooperatives surveyed and has largely replaced the so-called "Georgia buggy" in cooperative fertilizer plants. Varying in size, fast and highly maneuverable, these machines were used for a variety of jobs including unloading materials from boxcars, assembling and weighing ingredient materials, and loading out finished products.

Lift-hopper trucks were used by all cooperatives in unloading bulk materials from rail cars. These trucks could be maneuvered within boxcars and used to push materials onto under-car screw conveyors or to transport them to elevators for transfer to overhead shuttle conveyors or direct to storage bins.



Mixing unit and solution flow control equipment in fertilizer manufacturing plant operated by Mississippi Federated Cooperatives (AAL), Jackson.

In unloading bag materials, hand trucks were commonly used. Fork lifts were less common but seven cooperatives used them.

Liquid materials were generally unloaded by means of an air compressor which forced liquids through pipes direct to storage tanks or batching equipment.

Rock phosphate was commonly received in hopper cars. The phosphate was unloaded into an under-car screw conveyor for movement to storage bins.

For handling materials in the plant, lift-hopper trucks, belt conveyor systems, and bucket elevators were standard equipment for modern fertilizer manufacturing plants. Some of the smaller and older plants, however, still used the two-wheeled "Georgia buggy" extensively. Belt conveyor systems ranged from simple, portable types to elaborate, overhead shuttle systems in the more modern plants. Belt conveyors were frequently used to receive materials from bucket elevators, after such materials were unloaded by lift-hopper trucks, and transport them to storage bins. These conveyors were also used to transport raw mixed fertilizer from the mixing units to curing bins. Overhead cranes were used by two cooperatives.

In loading out bagged materials for distribution to locals or to farmers, handtrucks were used most commonly. Several cooperatives had installed bag conveyors that moved materials from the bagging unit direct to trucks. A few cooperatives used forklifts in loading out bagged materials.

Bulk materials were generally conveyed to a loading chute by

means of a belt conveyor and then discharged direct to bulk trucks.

Mechanization of fertilizer plants has been taking place at a rapid rate in recent years. Many of the plants covered in this study have not been able to keep pace with the trend toward mechanization because of the small volume produced and because buildings in some instances were not adaptable to mechanization. In renovating and modernizing old plants it may be necessary, in some instances, to consolidate one or more to have sufficient volume to reduce overhead costs to a satisfactory level. For example, automatic batching equipment is expensive machinery, and a considerable volume is necessary to justify installation of this equipment. However, in order to remain competitive it will be necessary for cooperatives to resort more and more to automation in their operations.

Granulation

Only three plants surveyed had granulation facilities in operation at the time of the study. However, two were in the process of installing granulating equipment and several others had rather definite plans for producing granular materials.

Granulation has not been adopted by the fertilizer industry in the South as rapidly as in other regions of the country. The main reasons for this seem to be:

1. The fertilizer industry of the South is older than in other parts of the country and productive capacity has long been adequate to supply current needs. Thus, not many new plants have been built in the South in recent years. In other areas of the country, consumption of fertilizer has been expanding rapidly and new facilities have been built to supply the expanding demand. Many of these new facilities were equipped with granulating machinery at the time they were constructed.

2. With nearby phosphate sources the advantages of high-analysis materials compared to low-analysis materials are not as apparent as in other sections of the country. Thus the need for granulation in connection with high-analysis materials is not as great.

With ever-increasing transportation costs, however, the advantages of high-analysis materials are becoming more apparent. Granular materials also are desirable for use with modern application equipment to prevent clogging. With continued mechanization of farm operations, this is becoming a more important factor. There is also increased interest in preventing separation of materials in fertilizer both in the distribution channels and when being spread. In granular materials each granule or pellet has all the essential elements bonded together. Therefore, separation of materials does not take place.

The outlook, therefore, is for an increasing proportion of fertilizer in the South to be granular material.

Some of the cooperative plants are becoming rapidly outdated. Buildings in some instances are in bad shape. Equipment is becoming badly worn, obsolete in some instances, and in need of replacement. Methods of handling in some plants are time consuming and costly. Plant layouts are not always conducive to efficient operation.

Modernization of old plants is becoming increasingly urgent. In modernizing, cooperatives should give due consideration to installing granulating and ammoniating facilities and more modern handling equipment. In some cases, in order to spread modernization costs, it may be advantageous to consolidate operations of one or more plants. This question should be examined carefully before undertaking extensive remodeling and modernization jobs.

Table 13.—Kinds of ingredients used by 35 cooperative plants in the manufacture of mixed fertilizer, 1956 [1]

Kind of material	Area I		Area II		Area III		South	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
Nitrogen	65. 0	13. 0	14. 6	18. 2	45. 6	33. 9	125. 2	17. 5
Phosphate	281. 5	56. 2	40. 7	50. 9	29. 2	21. 8	351. 4	49. 1
Potash	98. 8	19. 7	10. 0	12. 6	27. 8	20. 7	136. 6	19. 1
Secondary and trace	29. 7	5. 9	13. 6	16. 9	21. 5	16. 0	64. 8	9. 1
Conditioner and filler	26. 0	5. 2	1. 1	1. 4	10. 2	7. 6	37. 3	5. 2
Total	501. 0	100. 0	80. 0	100. 0	134. 3	100. 0	715. 3	100. 0

[1] Data were for 18 plants in Area I, 7 in Area II, and 10 in Area III. Only 31 of these plants were identical with those in the group of 35 reporting production in table 7. Ingredient information on the entire 35 plants was used in this report, however, to provide a more complete picture of cooperative operations. Data on ingredient purchases and use and on fertilizer produced were not sufficiently complete for identical plants to yield reliable shrinkage information.

Ingredients Used

Ingredients used in manufacturing mixed fertilizer may be classified into five categories as follows: (1) Nitrogen, (2) phosphate, (3) potash, (4) secondary and trace elements, and (5) conditioners and fillers.

Detailed information on ingredients used was obtained from 35 cooperative plants in the South. They used a total of 715,000 tons during their fiscal years ended in 1956 (table 13).[5] Nearly half of this amount, or 49.1 percent, was phosphate. About 19 percent was potash and 17.5 percent was nitrogen. Secondary and trace elements made up 9.1 percent, and the remaining 5.2 percent consisted of conditioners and fillers.

The proportion of these materials varied considerably among the three areas. In Area I, for example, phosphate made up 56.2 percent of the total compared to 50.9 percent in Area II and only 21.8 percent in Area III. Nitrogen, on the other hand, accounted for only 13 percent of the total in Area I, 18 percent in Area II, and about 34 percent in Area III. Potash was relatively less important in Area II, while secondary and trace elements were less important in Area I. Conditioners and fillers accounted for a larger proportion of ingredients used in Area III where they made up 7.6 percent of the total.

The various types of materials in each of the five principal ingredients used are discussed in the following section of this report.

Nitrogen Materials

Of the 125,000 tons of nitrogen materials used in the manufacture of mixed fertilizer in 1956 the most important was nitrogen solution, accounting for about 37 percent of the total (table 14). Sulfate of ammonia was second in importance, accounting for 27 percent of the total. Thus, these two materials combined accounted for nearly two-thirds of all the nitrogen used.

The relative importance of different nitrogen materials varied some-

[5] Only 31 of these plants were identical with those in the group of 35 plants reporting production in table 7. Ingredient information on the entire 35 plants was used in this report, however, to provide a more complete picture of cooperative operations. Data on ingredient purchases and use and on fertilizer produced were not sufficiently complete for identical plants to yield reliable shrinkage information.

what in different areas. For example, nitrogen solution made up 52 percent of the total nitrogen used in Area I, 58.5 percent in Area II, but only 8.4 percent in Area III. Likewise organic materials were of minor importance in Area I and II, but made up 28.4 percent of the total in Area III. Sulfate of ammonia was of major importance in Areas I and II, but of relatively minor importance in Area III. Conversely, ammonium nitrate was of little importance in mixed fertilizer manufacture in Areas I and II, but accounted for 23.6 percent of the total nitrogen used in Area III.

The only nitrate material used extensively in mixed fertilizer manufacture and produced by cooperatives in the South was ammonium nitrate. Mississippi Chemical Corp. produced this material, but most of its output was used for direct application rather than in mixtures.

Mississippi Chemical Corp. also produced anhydrous ammonia, but practically all of this production also was used for direct application.

Phosphate Materials

As previously mentioned, phosphate accounted for approximately half of all the raw materials used by the 35 cooperative plants to make mixed fertilizer in 1956. Of the 352,000 tons of phosphate used, approximately 93 percent was normal superphosphate (table 15). Next in importance was concentrated superphosphate, accounting for about 4 percent. Calcium metaphosphate made up a little over 1 percent of the total.

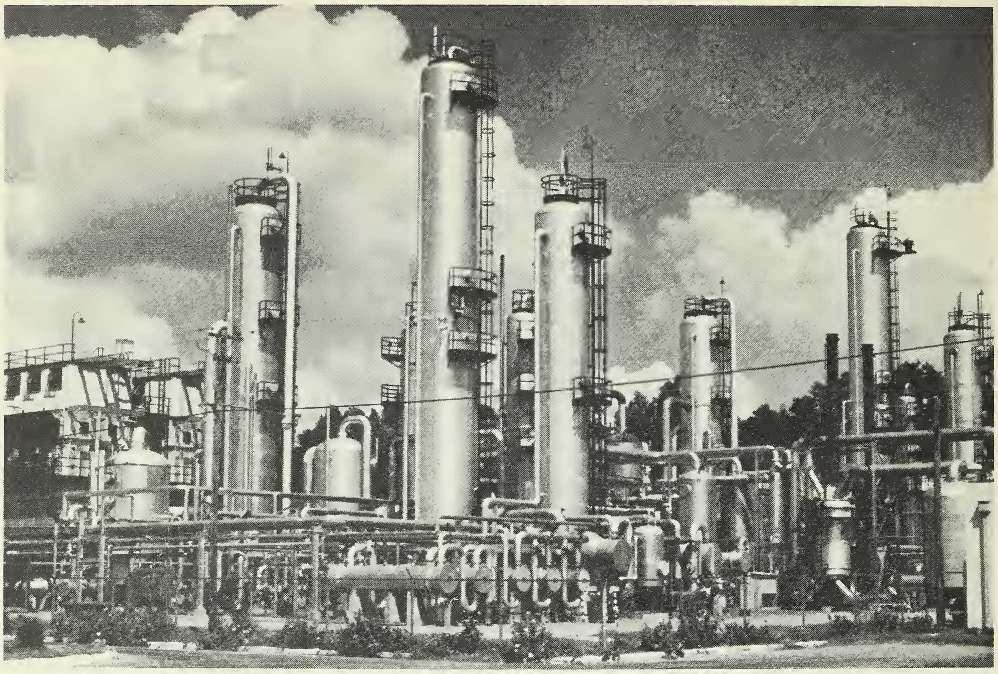
The major differences between areas in the use of phosphate in mixtures was the greater importance of concentrated superphosphate in Area II and of wet-base goods in Area III.

The only phosphate-carrying material manufactured by cooperatives in the South was normal superphosphate. Approximately 175,000 tons were produced in cooperative

Table 14.—Nitrogen materials used by 35 cooperative fertilizer plants in manufacture of mixed fertilizer, 1956

Nitrogen materials	Area I		Area II		Area III		South	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
Ammonium nitrate	0. 2	0. 3	0. 1	0. 7	10. 8	23. 6	11. 1	8. 8
Ammonium nitrate limestone	(1)	(2)	0	0	2. 1	4. 6	2. 1	1. 7
Calcium ammonium nitrate	0	0	. 1	. 5	1. 6	3. 5	1. 7	1. 4
Calcium nitrate	0	0	0	0	1. 4	3. 1	1. 4	1. 1
Cyanamid	1. 0	1. 6	(1)	(2)	(1)	. 1	1. 0	. 9
Nitrate of soda	. 1	. 1	(1)	. 1	9. 5	20. 8	9. 6	7. 6
Nitrogen solution	33. 9	52. 1	8. 5	58. 5	3. 8	8. 4	46. 3	36. 9
Organics [3]	1. 5	2. 2	0	0	12. 9	28. 4	14. 4	11. 5
Sulfate of ammonia	28. 4	43. 6	3. 1	21. 3	2. 5	5. 6	34. 0	27. 2
Urea	(1)	. 1	2. 6	17. 7	. 7	1. 5	3. 3	2. 6
Other	0	0	. 2	1. 2	. 2	. 4	. 3	. 3
Total	65. 1	100. 0	14. 6	100. 0	45. 5	100. 0	125. 2	100. 0

[1] Less than 50 tons.
[2] Less than 0.05 percent.
[3] Includes castor pomace, sewage sludge, nitrogenous tankage, tankage, lupine meal, cottonseed meal, bird guano, citrus meal, dried blood, feather tankage, and similar materials.



Mississippi Chemical Corp.'s ammonia plant at Yazoo City produces more than 270 tons of anhydrous ammonia daily. This is the basic material of MCC's nitrogen fertilizers. Part of the production is used for direct application and the rest is converted to other nitrogen fertilizers.

plants in fiscal 1956 and used primarily in the manufacture of mixed fertilizer. As indicated later, cooperatives manufactured approximately 37 percent of the normal superphosphate they used in manufacturing mixed fertilizer.

The 13,000 tons of concentrated superphosphate used in mixed fertilizer manufacture plus about an equal amount distributed by cooperatives would be insufficient and too widely scattered to justify building a cooperative plant to manufacture it. However, it is anticipated that this material will become increasingly important in the manufacture of mixed fertilizers

Table 15.—Phosphate materials used by 35 cooperative fertilizer plants in manufacture of mixed fertilizer, 1956

Phosphate materials	Area I		Area II		Area III		South	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
Wet-base goods	0. 8	0. 3	0	0	2. 2	7. 5	3. 0	0. 9
Calcium metaphosphate	4. 2	1. 5	(1)	. 1	0	0	4. 2	1. 2
Diammonium phosphate	. 8	. 3	(1)	. 1	0	0	. 8	. 2
Normal superphosphate	268. 5	95. 4	35. 1	86. 1	24. 8	85. 0	328. 4	93. 4
Concentrated superphosphate	6. 4	2. 2	5. 6	13. 7	1. 3	4. 6	13. 3	3. 8
Other	. 9	. 3	0	0	. 9	2. 9	1. 8	. 5
Total	281. 6	100. 0	40. 7	100. 0	29. 2	100. 0	351. 5	100. 0

[1] Less than 50 tons.

Table 16.—Potash materials used by 35 cooperative fertilizer plants in manufacture of mixed fertilizer, 1956

Potash materials	Area I		Area II		Area III		South	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
Muriate of potash	82. 7	83. 8	10. 0	99. 5	11. 6	41. 6	104. 3	76. 4
Sulfate of potash	8. 4	8. 5	0	0	. 7	2. 5	9. 1	6. 6
Sulfate of potash-magnesium	. 9	. 9	0	0	14. 9	53. 7	15. 8	11. 6
Tobacco stems	6. 7	6. 8	0	0	. 2	. 7	6. 9	5. 1
Other	0	0	. 1	. 5	. 4	1. 5	. 5	. 3
Total	98. 7	100. 0	10. 1	100. 0	27. 8	100. 0	136. 6	100. 0

and for direct application as increasing emphasis is given to high-analysis materials. It may be that at some future date cooperatives of the South will find it advantageous to manufacture their concentrated superphosphate needs in a jointly owned plant.

Potash Materials

The 35 cooperative plants used a total of 136,600 tons of potash materials during fiscal 1956 (table 16). Over three-fourths of this amount was muriate of potash (potassium chloride). Sulphate of potash-magnesium was the second most important potash material, accounting for 11.6 percent of the total. Sulfate of potash and tobacco stems accounted for 6.6 and 5.1 percent, respectively, of the total.

There were considerable differences in the use of potash among the three areas. Sulfate of potash and tobacco stems were of considerable importance in Area I, but were of only minor importance in the other two areas. Likewise, sulfate of potash-magnesium was the major potash material used in Area III, but it was unimportant in the other two areas.

Secondary and Trace Elements

The 35 cooperative plants used approximately 65,000 tons of secondary and trace elements in the manufacture of mixed fertilizer in 1956 (table 17).

Secondary element materials, consisting mostly of limestone, made up 97.3 percent of the total. Limestone was classified as a secondary element, although it is used in mixed fertilizer manufacture primarily to neutralize acid-forming materials rather than to supply the secondary plant food element, calcium.

Conditioners and Fillers

The 35 cooperative plants used approximately 37,000 tons of conditioners and fillers in mixed fertilizer manufacture (table 18). Most of this amount was inert materials. Areas I and III used most of the tonnage of conditioners and fillers.

Seasonality in Use of Ingredients

Seasonality in the use of the five kinds of ingredients used in the manufacture of 715,000 tons of mixed fertilizer by southern cooperatives in 1956 is shown in figure 4.

Two definite peaks were reached during the year—one in the spring and one in the fall. The spring peak came in April in Areas I and II and in May in Area III. The fall peak was reached in October in Areas I and II and in November in Area III.

Table 17.—Use of secondary and trace element materials in the manufacture of mixed fertilizer by 35 cooperative fertilizer plants, 1956

Kind of material	Area I		Area II		Area III		South	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
Secondary element:								
Limestone [1]	29. 4	99. 0	11. 0	80. 9	14. 1	65. 8	54. 5	84. 2
Other [2]	(3)	(4)	[5] 2. 6	19. 1	5. 9	27. 4	8. 5	13. 1
Trace element [6]	. 3	1. 0	(3)	(2)	1. 5	6. 8	1. 8	2. 7
Total	29. 7	100. 0	13. 6	100. 0	21. 5	100. 0	64. 8	100. 0

[1] Includes dolomite, burnt lime, and agricultural limestone.
[2] Includes magnesium sulfate, calcined magnesite, gypsum, elemental sulfur, and sulfuric acid.
[3] Less than 50 tons.
[4] Less than 0.05 percent.
[5] All this tonnage was sulfuric acid added during the mixing operation.
[6] Includes borax, "chelated iron," manganese oxide, copper oxide, iron oxide, copper sulphate, iron sulphate, manganese sulphate, zinc sulphate, zinc carbonate, zinc oxide.

In May mixing operations were curtailed sharply in all areas. June, July, and August were slack periods in Areas I and II, and July, August, and September were slack in Area III. Production operations also were sharply curtailed in December in Area I and in November in Area II.

Supplies of raw materials were generally contracted for during the slack summer season. Shipping dates were scheduled at this time for the entire year to insure a supply of raw materials on hand when needed. This meant that the entire year's operation had to be planned a year in advance.

Origin of Ingredients

Figure 5 shows locations of origin points for three classes of primary plant nutrients. It does not show origin points for secondary and trace elements and for conditioners and fillers. Limestone and filler were the major items in these categories, and they were obtained by and large, from local sources.

Table 18.—Conditioners and fillers used by 35 cooperative fertilizer plants in the manufacture of mixed fertilizer, 1956

Type of conditioner and filler	Area I		Area II		Area III		South [1]	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
Organic conditioners [1]	3. 5	13. 7	0	0	1. 4	13. 8	4. 9	13. 3
Phosphatic sand [2]	2. 1	8. 1	0	0	4. 4	43. 4	6. 5	17. 5
Inert materials [3]	20. 3	78. 2	1. 1	100. 0	4. 4	42. 8	25. 8	69. 2
Total	25. 9	100. 0	1. 1	100. 0	10. 2	100. 0	37. 2	100. 0

[1] Includes citrus fines, ground bark, peanut hulls, rice hulls, peat, and furfural residue.
[2] Includes material described as "phosphate filler."
[3] Includes materials described as "filler," "wet filler," vermiculite, terralite, zonolite, sand, silica, and "conditioner."

Figure 4.—Seasonal pattern of ingredients used by 35 cooperative mixed fertilizer plants in the South, yearended June 30, 1956

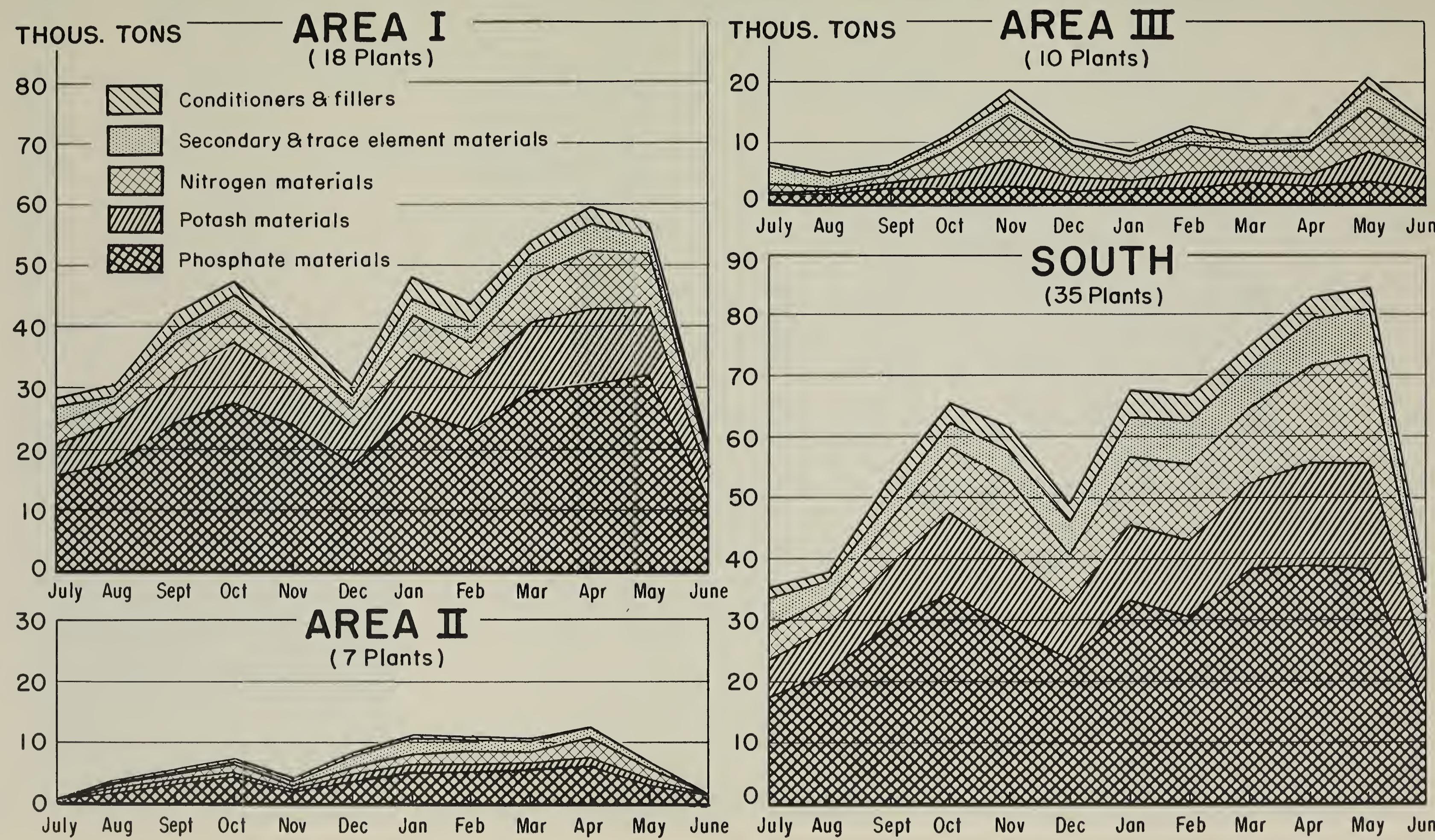
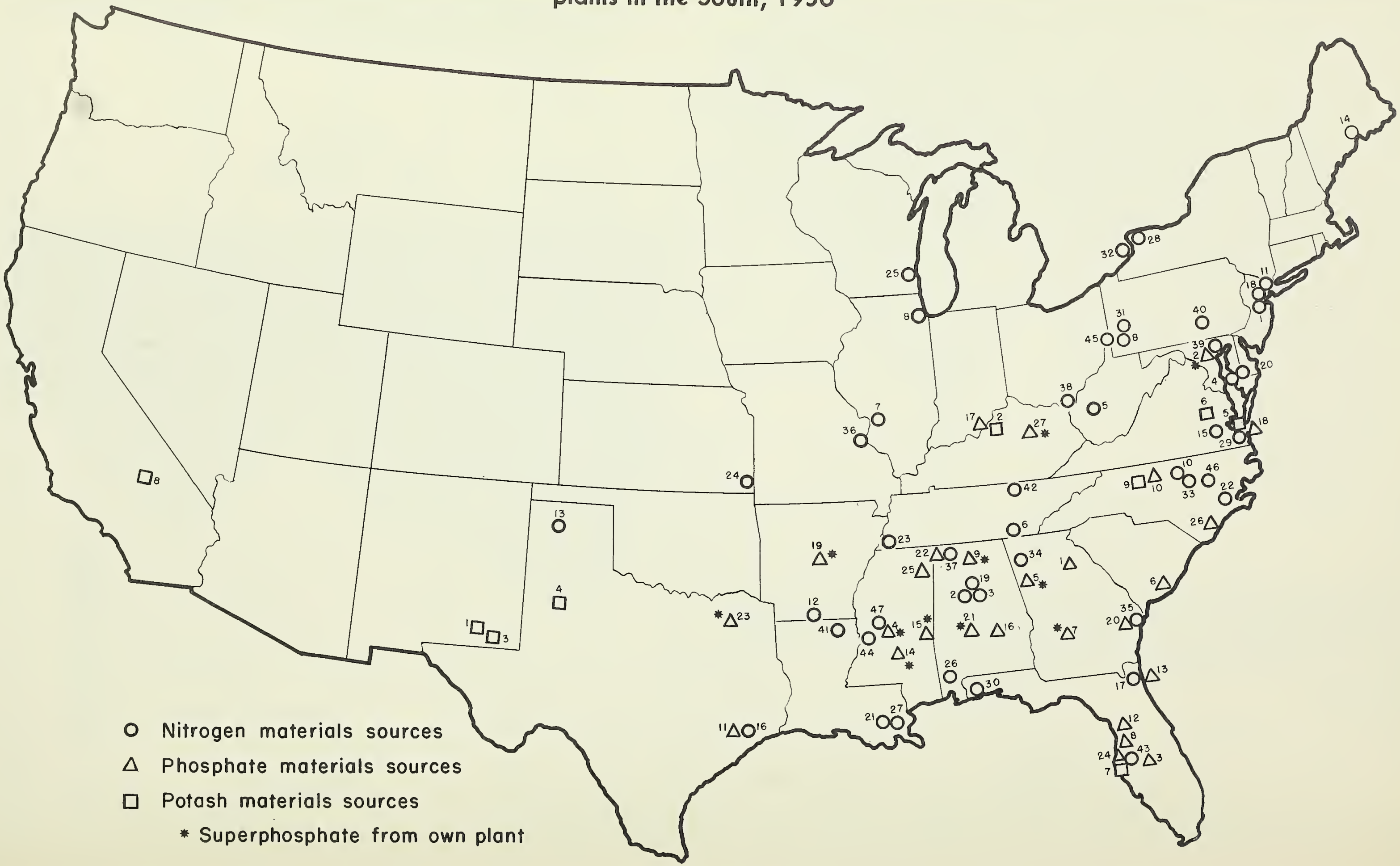


Figure 5.—Sources of primary plant nutrient materials used in mixed fertilizer manufactured by 35 cooperative fertilizer plants in the South, 1956



Shown are 47 origin points for nitrogen, 27 for phosphate, and 9 for potash.

Nitrogen solution, sulfate of ammonia, superphosphate, and muriate of potash were the four major primary nutrients used in mixing. These four materials combined accounted for 513,000 tons, or nearly 72 percent, of the 715,000 tons of materials used.

The tonnage figures obtained according to origin points represent plant receipts of the various materials. Therefore, they do not correspond to tonnage used since part of the tonnage received may have been distributed for direct application or accumulated in inventory.

The quantities of nitrogen solution purchased by the 35 cooperative plants in 1956 were:

Area:	*1,000 tons*
I	39.9
II	9.2
III	4.2
Total	53.3

Ten different origin points were used for nitrogen solution for these plants. Most important was Hopewell, Va., with Vicksburg, Miss., second in importance.

The quantities of sulfate of ammonia purchased by the 35 cooperative plants in 1956 were:

Area:	*1,000 tons*
I	32.3
II	3.4
III	2.6
Total	38.3

Fourteen origin points were used by these plants. Sparrows Point, Md., Hopewell, Va., Clairton, Pa., and Birmingham, Ala., were most important of these.

The quantities of superphosphate purchased by the 35 plants in 1956 were:

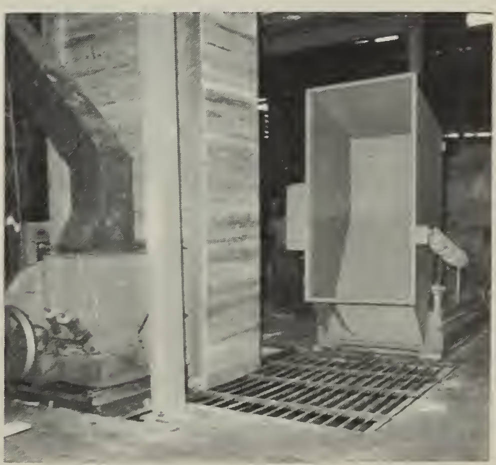
Area:	*1,000 tons*
I	305.9
II	55.4
III	25.2
Total	386.5

Cooperatives used 23 origin points for superphosphate. Baltimore, Md., and Norfolk, Va., were the two main sources of this material. Other origin points were widely scattered and each was mostly used as a source by only one plant.

Of their total plant supplies of superphosphate, cooperatives manufactured 141,700 tons, or 37 percent (table 19). On the other hand, about 245,000 tons, or 63 percent, were purchased on the open market.

Area I cooperatives produced some 92,000 tons of superphosphate which accounted for about 30 percent of total superphosphate supplies. This compared with 50,000 tons produced by Area II cooperatives, which made up 90 percent of superphosphate supplies in this area. Cooperatives of Area III did not have any superphosphate production of their own.

In view of the apparent underutilization of cooperative superphosphate acidulating facilities, as will be seen on pages 38–40 of this report, and purchases of 245,000



This dump hopper unit is in the Adel, Ga., fertilizer manufacturing plant of Cotton Producers Association, Atlanta, Ga.

Table 19.—Proportion of superphosphate receipts of 35 cooperative plants manufactured in own plants and purchased, 1956

Area	Own manufacture		Purchased		Total	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
I	91. 7	30. 0	214. 2	70. 0	305. 9	100. 0
II	50. 0	90. 3	5. 4	9. 7	55. 4	100. 0
III	0	0	25. 2	100. 0	25. 2	100. 0
South	141. 7	36. 7	244. 8	63. 3	386. 5	100. 0

tons on the open market, it seems greater coordination of superphosphate procurement is needed.

The quantities of muriate of potash purchased by the 35 plants in 1956 were:

Area:	*1,000 tons*
I	86. 9
II	14. 8
III	13. 8
Total	115. 5

Practically all the potash was obtained from the Carlsbad, N. Mex., area. Small amounts were obtained from Europe and from Trona, Calif., by cooperatives in Area I.

Transportation of Ingredients

Because of the bulky nature of fertilizer materials and the need for moving them long distances in many instances, transportation is an important element of cost. It has been variously estimated to make up from 25 to 40 percent of the retail price of fertilizer. Thus, of the more than $60 million worth of fertilizer manufactured by cooperatives in fiscal 1956, some $15 million to $24 million was used to pay costs of moving it from one point to another.

Handling Traffic

Five of the larger cooperatives studied had complete traffic departments. In general, these departments were in charge of routing inbound and outbound shipments, specifying modes of transportation to be used, auditing freight bills, contracting for motortruck carriers, chartering vessels, and handling insurance and claims against carriers for loss or damage. If the cooperative had no traffic department, it usually assigned the job of handling traffic to someone—either an assistant manager, plant superintendent, or an employee in the sales department.

One cooperative used over 2,400 rail cars for movement of inbound and outbound materials. Scheduling this number of shipments so as to take advantage of the best possible routes and lowest cost transportation and at the same time give the best possible service to patrons is a job needing full time and attention in an efficiently managed cooperative. Many cooperatives need to give greater emphasis to efficient handling of inbound and outbound traffic.

Mode of Transportation Used

Table 20 gives the mode of inbound transportation used for four major ingredient materials in mixed fertilizer manufacture, for all other materials, and for all materials by area. Over the South as a whole, 79 percent of all inbound tonnage moved by rail, some 12 percent by

Table 20.—Modes of transportation used for inbound materials to 35 cooperative fertilizer mixing plants, year ended June 30, 1956 [1]

Material and mode of transportation	Area I		Area II		Area III		South	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
Nitrogen solution:								
Rail	40.0	100.0	9.2	100.0	4.2	100.0	53.3	100.0
Sulfate of ammonia:								
Rail	32.3	100.0	2.6	75.1	2.3	89.8	37.2	97.1
Rail and water	-----	-----	----	-----	.3	10.2	.3	.7
Rail and truck	-----	-----	.9	24.9	-----	-----	.9	2.2
Total	32.3	100.0	3.5	100.0	2.6	100.0	38.4	100.0
Superphosphate (18–20 percent):								
Truck	62.9	28.5	----	-----	-----	-----	62.9	24.9
Rail	121.6	54.9	5.8	100.0	25.2	100.0	152.6	60.5
Water	20.4	9.2	----	-----	-----	-----	20.4	8.1
Rail and truck	16.4	7.4	----	-----	-----	-----	16.4	6.5
Total	[2] 221.3	100.0	[3] 5.8	100.0	25.2	100.0	252.3	100.0
Muriate of potash:								
Rail	85.6	98.5	14.8	100.0	9.6	69.6	110.0	95.2
Water	1.3	1.5	----	-----	-----	-----	1.3	1.1
Rail and water	-----	-----	----	-----	4.2	30.4	4.2	3.7
Total	86.9	100.0	14.8	100.0	13.8	100.0	115.5	100.0
Other materials:								
Truck	8.9	10.6	0.8	3.7	6.6	6.1	16.3	7.6
Rail	70.4	84.0	17.8	79.8	94.6	86.6	182.8	84.9
Water	3.7	4.4	----	-----	-----	-----	3.7	1.7
Rail and water	.1	.1	----	-----	8.0	7.3	8.1	3.8
Rail and truck	.7	.9	3.7	16.5	-----	-----	4.4	2.0
Total	83.8	100.0	22.3	100.0	109.2	100.0	215.3	100.0
All materials:								
Truck	71.8	15.5	0.8	1.5	6.6	4.3	79.2	11.7
Rail	349.9	75.3	50.1	90.3	136.0	87.7	536.0	79.4
Water	25.4	5.5	----	-----	-----	-----	25.4	3.8
Rail and water	.1	([4])	----	-----	12.5	8.0	12.6	1.9
Rail and truck	17.2	3.7	4.5	8.2	-----	-----	21.7	3.2
Total	464.4	100.0	55.4	100.0	155.1	100.0	674.9	100.0

[1] Does not include materials used in acidulating plants.
[2] Includes 7,034 tons of own manufactured superphosphate.
[3] Includes 400 tons of own manufactured superphosphate.
[4] Less than 0.05 percent.

truck, 4 percent by water, and about 5 percent by combinations of rail and water or rail and truck.

Rail movement on inbound materials was the most important method of transportation in all areas, accounting for from 75 to 90 percent of total volume in each area. Trucks were relatively more important in Area I, accounting for 15.5 percent of total volume compared with 4.3 percent in Area III and 1.5 percent in Area II. Water was important in Area I. However, a combination rail-and-water movement accounted for considerable volume in Area III. Most of this latter tonnage was muriate of potash out of New Mexico by water across the Gulf of Mexico and sludge

tankage out of Chicago via the Mississippi by barge.

The mode of transportation varied among different types of materials. For example, all nitrogen solution was moved by rail transportation. Considerable quantities of superphosphate were moved by rail and truck, with small quantities by water and a combination of rail and truck.

Water transportation is generally recognized as the most economical method of shipping fertilizer materials. Yet, less than 6 percent of the volume of materials received at cooperative mixing plants utilized this method of transportation. By coordinating procurement of raw materials of several cooperatives, there would seem to be considerable opportunity to make greater use of water transportation and effect savings for farmers. This possibility exists especially with muriate of potash out of New Mexico and with phosphate materials out of Florida. Where plants do not have direct access to water transportation, the possibilities for rail or truck in combination with water should be examined closely. The possible advantages of water transportation are such that cooperatives should consider it in locating future fertilizer manufacturing facilities.

The organizers of Coastal Chemical Corp. have recognized the advantages of water transportation and have constructed at Pascagoula, Miss., manufacturing facilities to take advantage of water rates.

Problems in Securing Adequate Rail Transportation

Table 21 lists problems reported by cooperative managers in obtaining adequate rail transportation for movement of inbound and outbound fertilizer materials. Eighteen managers reported having no special problems. Six managers stated that shortage of cars during certain seasons was an important problem. Delays up to 1 month caused by car shortages were reported. Most of these shortages related to shipments of potash out of Carlsbad, N. Mex. The heavy wheat shipping season was reported to be a particularly bad time to obtain adequate rail transportation for fertilizer materials.

Boxcars in poor condition were the second most important problem reported by cooperative managers. The most common condition reported was holes in floors, which allowed bulk materials to leak through. Many of the claims reported by cooperatives against carriers were a result of cars being in bad condition.

Claims Against Carriers

Claims against carriers filed by 29 cooperatives amounted to about $48,000 in 1956 (table 22). The amount of claims averaged about $2,200 per association. Five associations reported having no claims against carriers. More than half of those reporting claims (13 of 24)

Southern States Cooperative, Inc., makes use of water transportation at its Baltimore, Md., fertilizer manufacturing plant.

Table 21.—Problems reported by 28 cooperatives in securing adequate rail transportation, 1956

Problem	Cooperatives reporting[1]	
	Number	*Percent*
No special problems	18	64
Shortage of cars during certain seasons [2]	6	21
Box cars in poor condition [3]	5	18
Can't depend on time of arrival	2	7
Frequent changes in routes	1	4
Cars tied up in switchyards	1	4
Total	28	100

[1] Figures do not add to total because some cooperatives reported more than one problem.
[2] Managers reported delays up to 1 month because of car shortages. Most car shortages reported related to shipments of potash.
[3] Conditions reported included holes in floors, not fit for loading, inferior cars, and leaky cars.

had a total of $500 or even less.

As to the size of individual claims, 11 associations reported filing 108 claims that totaled $30,656, an average of $284 a claim.

Use of Covered Hopper Cars

Table 23 shows use cooperatives made of covered hopper cars for incoming materials. Nine cooperatives reported using this type car for from two-thirds to all of their incoming phosphate rock. Five associations reported using covered hopper cars for muriate of potash. Two of these moved from one-third to two-thirds and three reported moving from two-thirds to all of their incoming muriate of potash tonnage by this method. Other materials moved in covered hopper cars—each by one cooperative—were tobacco stems, sulphate of ammonia, concentrated superphosphate, and dolomitic limestone.

Of 28 associations reporting, 10 used covered hopper cars for 1 or

Table 22.—Frequency distribution of total amount of claims filed against carriers on fertilizer materials by 29 southern cooperatives, year ended June 30, 1956

Amount of claims [1]	Cooperatives reporting	
	Number	*Percent*
None	5	17. 0
$1 to $500	13	45. 0
$501 to $1,500	2	7. 0
$1,501 to $2,500	1	3. 5
$2,501 to $3,500	0	0
$3,501 to $4,500	1	3. 0
$4,501 to $5,500	4	14. 0
Over $5,500	1	3. 5
Amount not available	2	7. 0
Total	29	100. 0

[1] Total claims reported filed were $47,731, or $2,170 per association.

Table 23.—Use of covered hopper cars for incoming materials by 10 cooperative fertilizer manufacturers, 1956

Material received	Proportion of tonnage in covered hopper cars	
	One-third to two-thirds	Two-thirds to all
	Number of cooperatives	
Rock phosphate	0	9
Muriate of potash	2	3
Tobacco stems	0	1
Sulfate of ammonia	0	1
Concentrated superphosphate	0	1
Dolomitic limestone	0	1

more incoming ingredient materials. The use of this type car was reported to be increasing because of the ease of unloading bulk materials. More and more cooperatives are installing under-car screw conveyor systems to handle receipts of bulk materials in hopper cars.

Freight Rate Activity

Cooperative fertilizer manufacturers in the South have made active efforts to obtain more favorable freight rates on fertilizer materials. A total of 21 reported some action taken, as shown in

Table 24.—Actions taken by cooperatives to obtain more favorable freight rates on fertilizer

Nature of action taken	Cooperatives[1] reporting	
	Number	*Percent*
Worked through industry, State or co-op group	11	52
Submitted briefs or complaints at hearings	6	29
Shifted to use of trucks	2	10
Offered to negotiate with railroads	2	10
Hired services of traffic consultants	2	10
Sent own representative to ICC hearings	1	5
Contacted Congressman	1	5
Made freight rate survey in locating plant	1	5
Applied for special rates	1	5
Obtained special rate through direct negotiation with railroad	1	5
Total	21	---------
Cooperatives reporting no action taken	5	---------
Cooperatives not reporting	3	---------
Total cooperatives	29	100

[1] Figures do not add to total because some reported more than one action.

table 24. The most common way of working for lower freight rates was through industry, State, or cooperative groups. Eleven associations reported taking action of this kind. Six associations reported submitting briefs or complaints at freight rate hearings. Other cooperatives attempted to influence rates by shifting part of their tonnage to trucks, offering to negotiate with the railroads, hiring services of traffic consultants, sending representatives to ICC hearings, and applying for special rates in certain cases.

In Area III, several cooperatives reported participating in activities of the Inland Fertilizer Council. This group was successful in obtaining adjustments in rates to inland cities to bring them more in line with rates to port cities. Rates to port cities had been set lower than to inland cities because of competing water transportation. This applied especially to potash from New Mexico.

Manufacture of Superphosphate

COOPERATIVES in this study operated 13 superphosphate manufacturing plants with 8 in Area I and 5 in Area II. All made normal superphosphate through acidulation of finely ground phosphate rock with sulfuric acid. One cooperative produced enriched superphosphate (27½ to 30 percent P_2O_5) with its acidulating equipment through the use of phosphoric acid.

Production Trends

Production of superphosphate by the 13 cooperative plants from 1951 through 1956 is shown in table 25. Their output increased from 112,500 tons in 1951 to 174,600 tons in 1956, an increase of approximately 55 percent. Production went up each year with the exception of 1953 when it fell below the previous year. Production in Area I jumped 74 percent compared with 23 percent in Area II. None of the cooperatives in Area III had superphosphate plants.

Superphosphate production is compared with the total used in mixtures and distributed as straight material in table 26. An estimated 408,100 tons of superphosphate were used in mixtures by the 42 cooperative plants in the South. Another 37,900 tons were distributed as straight material, thus bringing the total superphosphate used and distributed to 446,000 tons. The production of 174,600 tons, therefore, was about 39 percent of total needs. Area I cooperatives produced 35 percent of their

Table 25.—Superphosphate production by 13 cooperative plants in the South, 1951–56

Year ending June 30—	Area I	Area II	South
		1,000 tons	
1951	71. 7	40. 8	112. 5
1952	87. 4	37. 6	125. 0
1953	70. 8	40. 6	111. 4
1954	87. 9	53. 0	140. 9
1955	102. 1	49. 4	151. 4
1956	124. 6	50. 0	174. 6

Table 26.—Comparison of superphosphate volume manufactured with that used in mixtures and distributed as straight material, year ended June 30, 1956

Superphosphate (18–20 percent)	Area I	Area II	Area III	South
		1,000 tons		
Used in mixtures [1]	345. 8	36. 4	25. 9	408. 1
Distributed as straight material	8. 8	27. 8	1. 3	37. 9
Total	354. 6	64. 2	27. 1	446. 0
Manufactured [2]	124. 6	50. 0	0	174. 6
		Percent		
Proportion of total volume manufactured	35. 1	77. 9	0	39. 1

[1] Estimated total of 42 mixing plants based on actual use by 35 plants.
[2] Manufactured volume of 13 plants.

needs compared to 78 percent in Area II.

Facilities and Operations

Detailed information on facilities and operations was obtained on 11 of the acidulating plants—6 in Area I and 5 in Area II. Each cooperative also operated mixing plants at the same location. Although located in the same or adjacent buildings, the acidulating and mixing operations were entirely separate.

Acidulating Units

Of the 11 superphosphate plants, 6 had batch-type acidulating units and 5 had continuous units.

Capacities.—Data on rated capacities of acidulating units per 8-hour shift are summarized in the following tabulation.

Area	Number of plants	Range in capacities	Average capacity
		Tons	*Tons*
I	6	80 to 160	140
II	5	120 to 200	154
South	11	80 to 200	146

This indicates all cooperative plants in the region were small to medium in size. Large plants would range in capacity from 300 to 400 tons per 8-hour shift.

Total production of superphosphate by the 11 plants for the fiscal year ended June 30, 1956, was 143,580 tons, or an average of 12,871 tons per plant. Approximately 92,000 tons of this amount were produced in the six plants located in Area I and 50,000 tons in the five plants in Area II. The average output per plant in Area I was 15,273 tons compared to 9,988 tons per plant in Area II. The range in output per plant was from 6,000 to 26,000 tons in Area I and from 6,400 to 14,700 tons in Area II.

Operating Efficiency.—An idea of the efficiency of acidulating units in fiscal year 1956 may be obtained from the following data on number of shifts they operated and the wide variation among plants:

Area	Plants	Range in shifts operated	Average of shifts operated
		Number	
I	6	35 to 200	128
II	5	31 to 160	89
South	11	31 to 200	110

If one assumes that all plants could have operated 200 shifts a year, as 2 plants actually did, then the average of 128 shifts and 89 shifts in Areas I and II, respectively, indicates that plants operated at considerably less than their maximum capacity.

Efficient use of acidulating plant facilities is determined by the number of shifts operated during the year and also the rate of operation when the facility is being used. Thus, if an acidulating unit is operating 200 shifts a year but at a rate of only 50 percent of its rated capacity, it is operating at only 50 percent efficiency.

The actual output per 8-hour shift of plants when in operation in 1956 is shown in the next tabulation.

Area	Plants	Range in actual output per shift	Average output per shift	Percent of rated capacity
	Number	*Tons*	*Tons*	*Percent*
I	6	80 to 179	119	85
II	5	84 to 207	112	73
South	11	80 to 207	116	79

This indicated that acidulating plants in Area I operated at about 85 percent of rated capacity during the time they were in operation. This compared with 73 percent in Area II and about 79 percent for all 11 plants.

Another indication of the effi-

The Louisville, Ky., fertilizer manufacturing plant of Southern States Cooperative, Inc., Richmond, Va.

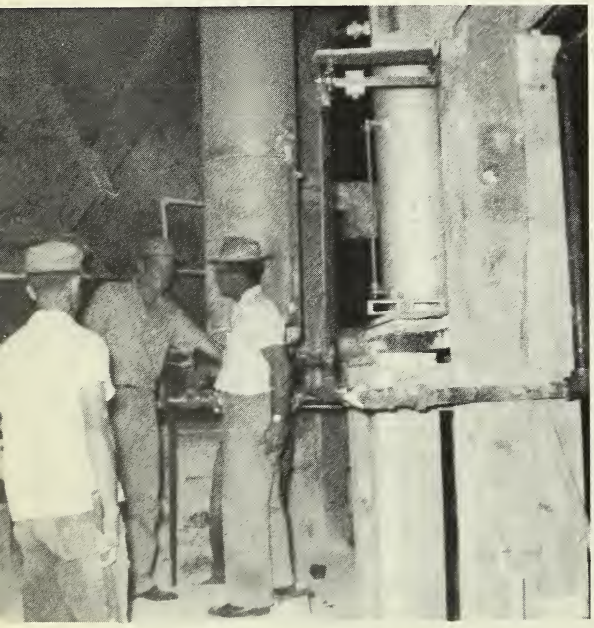
ciency with which acidulating units were utilized was obtained by dividing the year's output by the rated capacities of the plant per 8-hour shift. This calculation gave the number of days of operation at rated capacity that would be required to produce the equivalent of the 1956 output of the plant.

Results for Areas I and II and the South are shown in the following tabulation.

Area	Plants	Days of operation at capacity required to produce 1956 output	
		Range	Average
	Number	*Days*	*Days*
I	6	38 to 214	109
II	5	32 to 113	65
South	11	32 to 214	88

Thus, plants of Area I, if operating at their rated capacity, could have produced their total superphosphate output for 1956 in 109 days of operation. Similarly, plants in Area II could have produced their entire 1956 output in 65 days of operation at rated capacity.

Since two plants required 200 days of operation or more to produce their annual output it seems that, in general, acidulating capacity was not utilized at a satisfactory level of efficiency during fiscal year 1956.



Dual solution setup in fertilizer manufacturing plant, Carrollton, Ga., operated by Cotton Producers Association, Atlanta, Ga.

Storage Capacity and Turnover

Raw material storage capacity at the 11 acidulating plants totaled approximately 9,000 tons. Approximately 6,400 tons of this was allocated to rock phosphate storage and 2,600 tons to sulfuric acid.

Raw materials storage averaged approximately 815 tons a plant. This was divided 580 tons for rock and 235 tons for acid. The average ratio of rock storage to acid storage was 2.5.

Storage capacities in individual plants ranged from 235 tons to 2,800 tons. Rock phosphate storage ranged from a minimum of 150 tons at one plant to a maximum of 2,000 tons at another plant. Acid storage ranged from 50 tons to 850 tons.

Storage Capacity Related to Production Capacity.—Because of uncer-

Mississippi Federated Cooperatives' plant at Canton, Miss., manufactures superphosphate and mixed goods for distribution through its member local co-ops.

tainties in supplies and delays in transportation, raw materials storage in relation to production capacity is often an important consideration. By dividing the total raw materials storage capacity by the rated capacity of the acidulating unit per 8-hour shift, the number of days of operation represented in raw materials storage by cooperative plants in the South is shown in the next tabulation.

Area	Plants	Days of operation in raw materials storage	
		Range	Average
	Number	*Days*	*Days*
I	6	2. 5 to 8. 1	5. 2
II	5	1. 8 to 14. 1	5. 9
South	11	1. 8 to 14. 1	5. 6

In other words, acidulating plants could be operated, on the average, 5.6 days without replenishing supplies of raw materials.

Finished Products Storage. Storage of finished products at acidulating plants totaled 53,200 tons and averaged approximately 4,800 tons a plant. Total capacity was divided about the same by areas—25,200 tons in Area I and 28,000 tons in Area II. Average capacity was 4,200 tons a plant in Area I and 5,600 tons a plant in Area II. The range in plant capacity was from 1,200 tons to 9,000 tons in Area I, and from 4,000 to 8,000 tons in Area II.

The ratio of finished products storage to raw materials storage averaged 5.9 for all 11 plants. The range in this ratio was from 2 to 12 in Area I and from 3 to 30 in Area II. The average ratio was 5.7 in Area I and 6.1 in Area II.

Storage Turnover.—A rough measure of efficiency in utilization of storage capacity was obtained by dividing output for fiscal year 1956 by tons of storage capacity. This calculation gave turnover in storage capacity for the year.

The turnover in raw materials storage capacity is shown at top of next page.

These data indicated that cooperatives in Area I made much more efficient use of their raw materials

Area	Plants	Range in turnover	Average turnover
	Number	*Times per year*	
I	6	4. 7 to 36. 6	20. 8
II	5	4. 2 to 33. 1	11. 0
South	11	4. 7 to 36. 6	15. 8

storage capacity in acidulating plants than cooperatives in Area II.

Turnover in finished product storage is shown in the next tabulation.

Cooperatives of Area I also made

Area	Plants	Range in turnover	Average turnover
	Number	*Times per year*	
I	6	2. 0 to 13. 4	3. 6
II	5	1. 0 to 2. 7	1. 8
South	11	1. 0 to 13. 4	2. 7

more efficient use of finished products storage capacity than cooperatives of Area II.

Procurement and Use of Ingredients

Sulfuric acid and phosphate rock are the two ingredients used in manufacturing superphosphate. Procurement and use of these ingredients was examined from the standpoint of (1) amounts and origins of ingredients purchased, (2) ingredients use, and (3) seasonal pattern of ingredients use.

Amounts and Origins of Ingredients Purchased

The 35 cooperative plants purchased 67,500 tons of sulfuric acid from 6 origin points in 1956. Cooperatives in Area I obtained 25,000 tons. The principal origin point was Copperhill, Tenn., with Fort Worth, Tex., next in importance.

A total of 85,600 tons of phosphate rock was purchased by the cooperative acidulating plants in 1956. Of this quantity, 54,400 tons went into Area I and 31,200 tons went into Area II.

All the phosphate rock used in these plants was obtained from Florida, with the major portion coming from the Bartow area.

Ingredients Use

The quantity of ingredients used and the production of superphosphate by the 11 cooperative plants in 1956 is shown in table 27.

These data indicate that shrinkage for all 11 plants averaged about 6.7 percent. The amount of shrinkage in Area I averaged 7.5 percent compared to 5.2 percent in Area II. Most of the shrinkage was due to loss of moisture during the acidulating process.

Fertilizer technologists indicate that a shrinkage of from 5 to 10 percent in the manufacture of superphosphate can be considered normal depending to some extent on the strength of the acid used.

Seasonal Pattern of Ingredients Use

For the 11 plants together, the period August through January accounted for most of the super-

Table 27.—Sulfuric acid and phosphate rock used and finished superphosphate produced in 11 acidulating plants, 1956

Material	Area I	Area II	South	
	1,000 tons	*1,000 tons*	*1,000 tons*	*Percent*
Sulfuric acid used	43. 5	23. 1	66. 6	43. 9
Phosphate rock used	55. 5	29. 6	85. 1	56. 1
Total	99. 0	52. 7	151. 7	100. 0
Superphosphate produced	91. 6	49. 9	141. 6	100. 0

phosphate manufactured in fiscal 1956 (fig. 6). The spring months of February through June were relatively light, with some upturn in operations during April and May.

The pattern of ingredients use varied considerably between the two areas. In Area I, the peak of operations was reached in October. It then began to decline until February, when it leveled off for the remainder of the spring months. In Area II the peak of production was not reached until December. Production then dropped each month through March

Table 28.—Tonnage and percentage of phosphate rock and sulfuric acid used in cooperative acidulating plants, by month, year ended June 30, 1956

Material and month	Area I		Area II		South	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
Sulfuric acid:						
July	1. 0	2. 3	1. 3	5. 6	2. 3	3. 4
August	4. 2	9. 7	2. 1	9. 1	6. 3	9. 5
September	5. 4	12. 4	1. 5	6. 5	6. 9	10. 4
October	6. 0	13. 8	1. 3	5. 6	7. 3	11. 0
November	5. 1	11. 7	2. 0	8. 7	7. 1	10. 7
December	3. 9	9. 0	2. 9	12. 6	6. 8	10. 2
January	3. 8	8. 7	2. 7	11. 7	6. 5	9. 8
February	2. 6	6. 0	2. 2	9. 5	4. 8	7. 2
March	2. 8	6. 4	1. 6	6. 9	4. 4	6. 6
April	2. 4	5. 5	2. 9	12. 6	5. 3	7. 9
May	3. 3	7. 6	1. 9	8. 2	5. 2	7. 8
June	3. 0	6. 9	. 7	3. 0	3. 7	5. 5
Total	43. 5	100. 0	23. 1	100. 0	66. 6	100. 0
Phosphate rock:						
July	1. 3	2. 4	1. 7	5. 7	3. 0	3. 5
August	5. 4	9. 8	2. 8	9. 5	8. 2	9. 6
September	7. 0	12. 7	1. 9	6. 4	8. 9	10. 4
October	7. 8	14. 0	1. 6	5. 4	9. 4	11. 1
November	6. 8	12. 3	2. 5	8. 5	9. 3	10. 9
December	5. 2	9. 4	3. 8	12. 8	9. 0	10. 6
January	4. 9	8. 7	3. 5	11. 8	8. 4	9. 9
February	3. 4	6. 1	2. 8	9. 5	6. 2	7. 2
March	3. 4	6. 2	2. 0	6. 8	5. 4	6. 4
April	3. 0	5. 3	3. 7	12. 5	6. 7	7. 9
May	4. 0	7. 2	2. 5	8. 4	6. 5	7. 6
June	3. 3	5. 9	. 8	2. 7	4. 1	4. 9
Total	55. 5	100. 0	29. 6	100. 0	85. 1	100. 0

Figure 6.—Seasonal pattern of ingredients used in the manufacture of superphosphate, year ended June 30, 1956

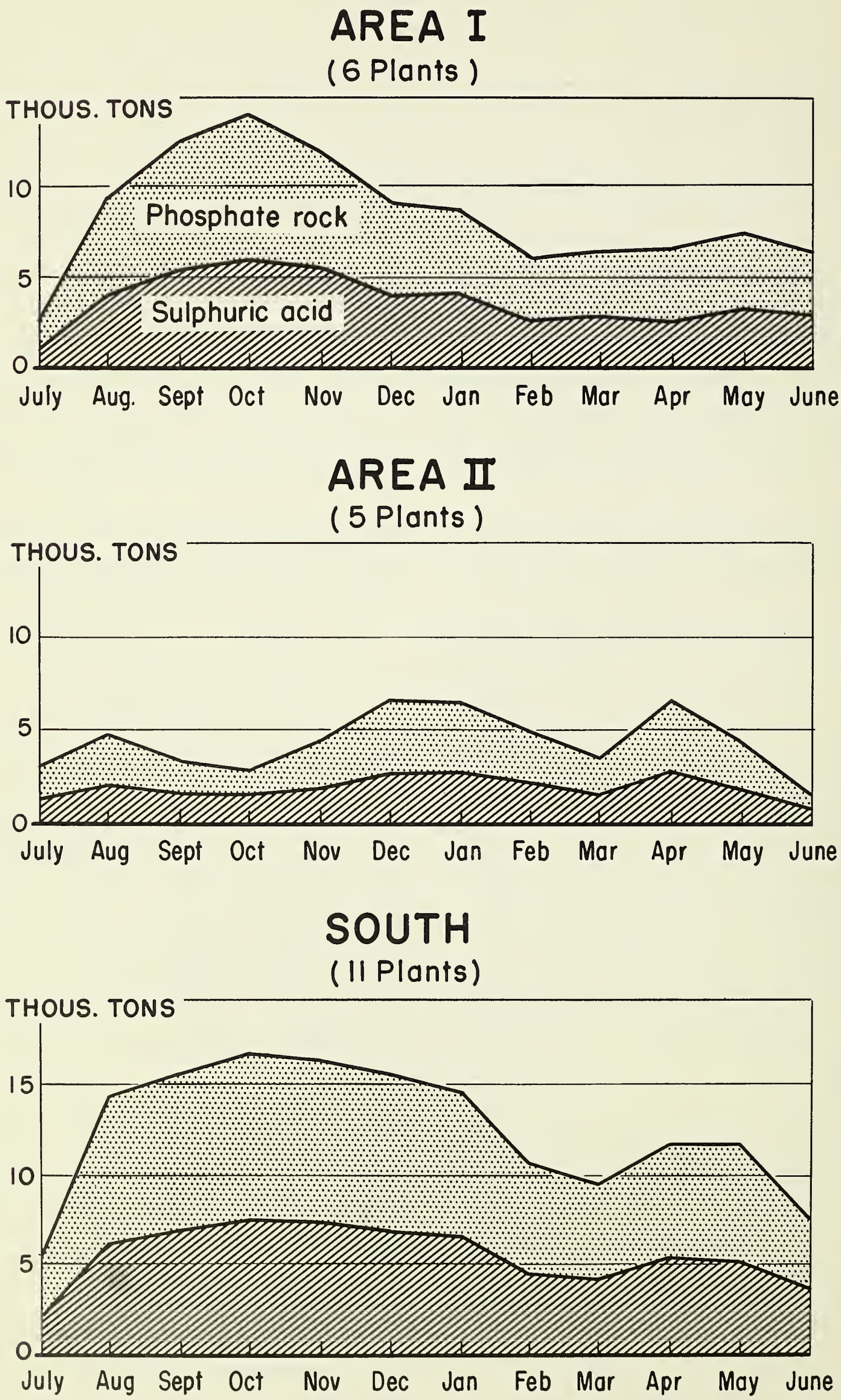


Table 29.—Mode of transportation for materials used in acidulating plant operations, 1956

Area and mode of transportation	Sulfuric acid		Phosphate rock		Total	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*	*1,000 tons*	*Percent*
Area I:						
Truck	11. 9	27. 9	0	0	11. 9	12. 2
Rail	28. 7	67. 4	54. 4	100. 0	83. 1	85. 7
Water	2. 0	4. 7	0	0	2. 0	2. 1
Total	42. 6	100. 0	54. 4	100. 0	97. 0	100. 0
Area II:						
Truck	5. 7	23. 0	0	0	5. 7	10. 2
Rail	19. 2	77. 0	31. 3	100. 0	50. 5	89. 8
Total	24. 9	100. 0	31. 3	100. 0	56. 2	100. 0
South:						
Truck	17. 6	26. 0	0	0	17. 6	11. 5
Rail	47. 9	71. 0	85. 6	100. 0	133. 6	87. 2
Water	2. 0	3. 0	0	0	2. 0	1. 3
Total	67. 5	100. 0	85. 6	100. 0	153. 2	100. 0

but considerable upturn occurred in April. June and July were slack months in both Areas I and II.

Table 28 gives tonnages and percentages of phosphate rock and sulfuric acid used each month for fiscal 1956.

Transportation of Ingredients

Table 29 gives modes of transportation used in movement of sulfuric acid and phosphate rock from origin points to cooperative acidulating plants. Rail movement accounted for 87 percent of total tonnage of acid and rock. About 11.5 percent was moved by truck, while water transportation accounted for only 1.3 percent.

Of the 67,500 tons of sulfuric acid receipts, 71 percent moved by rail, 26 percent by truck, and 3 percent by water. Rail and truck movement were of about the same relative importance in Areas I and II. All the water movement occurred in Area I. It consisted entirely of sulfuric acid shifted across the harbor in Baltimore.

All phosphate rock used in cooperative acidulating plants moved by rail. As was true in transportation of ingredients for mixed fertilizer, a considerable part of the volume moved in covered hopper cars. This makes for efficient handling of materials upon arrival at the plant, and more and more cooperatives are installing under-car screw conveyor systems to handle receipts of phosphate rock in this type car.

Manufacture of Nitrogen Materials

THE only cooperative manufacture of nitrogen materials in the southern region at the time of this study was that of Mississippi Chemical Corp. in its plant at Yazoo City. This cooperative, referred to as MCC, was founded in 1948 to supply its farmer and cooperative members with basic nitrogen materials which were then short in

Table 30.—Production of anhydrous ammonia and ammonium nitrate by Mississippi Chemical Corp., 1951–58

Year ended June 30—	Anhydrous ammonia [1]	Ammonium nitrate
	1,000 tons	
1951	4. 5	4. 4
1952	25. 5	36. 7
1953	41. 8	62. 1
1954	50. 0	70. 8
1955	71. 8	112. 8
1956	96. 1	143. 2
1957	97. 3	160. 6
1958	93. 3	171. 8

[1] Includes anhydrous ammonia used in producing ammonium nitrate.

supply.[6] It was the first attempt at cooperative production of basic fertilizer materials in the United States. The outstanding success of this venture helped stimulate interest among cooperatives all over the Nation in efforts to gain control of basic sources of supplies.

Production Trends

The materials produced in MCC's plant at Yazoo City are anhydrous ammonia (82.2 percent nitrogen) and ammonium nitrate (33.5 percent nitrogen). The output of these two materials for fiscal 1956 was nearly four times that of 1952—the first full year of operation (table 30). It was necessary to add additional production units to the initial installations to meet the rapid expansion in demand.

The tonnage of selected nitrogen materials used in manufacturing or distributed by cooperatives is compared with the tonnage manufactured in cooperative plants in table 31. The materials shown are those that are presently produced by cooperatives or appear to offer good possibilities for cooperative production.

Total anhydrous ammonia used in manufacture or distributed for direct application amounted to 105,800 tons. MCC used about three-fifths of this tonnage in producing ammonium nitrate. The tonnage of anhydrous ammonia manufactured was equivalent to about 91 percent of the total used in manufacture and distributed for direct application. The tonnage of ammonium nitrate manufactured was equivalent to about 60 percent of total needs of cooperatives.

All of the nearly 58,000 tons of nitrogen solution used or distributed by cooperatives had to be purchased on the open market. Production of this material appears to offer a good possibility for joint development by cooperatives in the South.

Output of anhydrous ammonia fluctuated little from month to month in MCC's plant during fiscal 1956 (table 32). Production varied from a low of about 7,000 tons in July to a high of 8,600 tons in January.

Monthly output of ammonium nitrate was more variable than output of anhydrous ammonia, ranging from 8,342 tons in April, or 5.8 percent of annual output,

[6] In February 1956, MCC directors voted to establish a subsidiary corporation—Coastal Chemical Corp.—to manufacture high-analysis water soluble fertilizers. This subsidiary built and began operating such a plant at Pascagoula, Miss., in 1958.

to 16,703 tons in March, or 11.7 percent of annual output.

Efficient use of manufacturing capacity requires close coordination of manufacturing, storage, and distribution programs. Distribution practices must be designed to move material out of the plant as rapidly as possible after manufacture. MCC offered attractive offseason storage allowances to farmers and dealers to encourage such movement.

Facilities and Operations

MCC's plant at Yazoo City consisted essentially of three basic sections—an ammonia section, a nitric acid section, and an ammonium nitrate section.

The ammonia section of the plant was first placed in operation in June 1951. The original section was constructed to produce 120 tons of ammonia per 24-hour day. Since

Side view of continuous ammoniating unit in manufacturing plant of Foremost Fertilizer Co., Leesburg, Fla. This unit will make 10–10–10, 8–16–0, and possibly 14–0–14 fertilizers. It is expected to increase the plant's production by about 10,000 tons annually.

Table 31.—Tonnage of selected nitrate materials used in manufacture and distributed by cooperatives compared with tonnage manufactured in cooperative plants, year ended June 30, 1956

Area and material	Used in manufacture and distributed	Manufactured	
		Amount	Proportion of total
	1,000 tons	*1,000 tons*	*Percent*
Area I:			
Anhydrous ammonia	0. 2	0	0
Ammonium nitrate	73. 9	0	0
Nitrogen solution	44. 8	0	0
Area II:			
Anhydrous ammonia	105. 6	96. 1	91. 0
Ammonium nitrate	147. 4	143. 2	97. 2
Nitrogen solution	8. 8	0	0
Area III:			
Anhydrous ammonia	0	0	0
Ammonium nitrate	16. 2	0	0
Nitrogen solution	4. 1	0	0
South:			
Anhydrous ammonia	105. 8	96. 1	90. 8
Ammonium nitrate	237. 5	143. 2	60. 3
Nitrogen solution	57. 7	0	0

Table 32.—Monthly production of anhydrous ammonia and ammonium nitrate by Mississippi Chemical Corp., year ended June 30, 1956

Month	Anhydrous ammonia		Ammonium nitrate	
	1,000 tons	*Percent*	*1,000 tons*	*Percent*
July	7.0	7.3	10.9	7.6
August	7.3	7.6	12.1	8.4
September	8.2	8.5	7.1	5.0
October	8.0	8.3	14.4	10.1
November	7.7	8.0	12.5	8.7
December	8.5	8.9	12.9	9.0
6-month total	46.7	48.6	69.9	48.8
January	8.6	9.0	13.1	9.1
February	7.5	7.8	11.6	8.1
March	8.6	8.9	16.7	11.7
April	8.4	8.8	8.3	5.8
May	8.4	8.7	12.9	9.0
June	7.9	8.2	10.7	7.5
6-month total	49.4	51.4	73.3	51.2
Year's total	96.1	100.0	143.2	100.0

that time three additions have been made to boost its capacity to 270 tons a day.[7] Actual production in fiscal 1956 averaged approximately 263 tons a day, or about 98 percent of the plant's designed capacity.

The original nitric acid section in MCC's Yazoo City facilities consisted of two war surplus units with a daily capacity of 110 tons. A third war surplus unit was added in August 1952 which boosted daily nitric acid capacity to 165 tons. Capacity was further increased in October 1954, when a second expansion unit was added which had a capacity equal to the other three units. It increased MCC's nitric acid capacity to 330 tons a day.[8]

[7] The ammonia plant was expanded again in 1958 to a total of 310 tons per 24-hour day.

[8] The nitric acid plant was expanded again in 1958 to a total of 450 tons per 24-hour day. Also, during the summer of 1958, MCC authorized construction of a urea plant that will provide 100 tons of solid urea per 24-hour day and make 50 tons of high nitrogen liquid fertilizers per 8-hour day for direct application.

MCC produced its first ammonium nitrate in March 1951 from MCC-produced nitric acid and purchased ammonia. The original ammonium nitrate section had a daily capacity of 140 tons. This was increased to 190 tons in August 1952 and to approximately 380 tons in October 1954.[9] Production for fiscal 1956 averaged about 392 tons a day, or 103 percent of designed capacity.

The plant at Pascagoula, Miss., completed by MCC's subsidiary, Coastal Chemical Corp., had the following capacities in 1958:

a. High-analysis fertilizer; 300 tons per 24-hour day. (Complete granular fertilizer such as 14–14–14, 6–24–24, 16–20–0, and 9–27–18.)

b. Superphosphate (18 to 20 percent P_2O_5), 150 tons per 8-hour day.

c. Triple superphosphate (46 to 48 percent P_2O_5), 150 tons per 8-hour day.

[9] The ammonium nitrate section was expanded again in 1958 to a total of 475 tons per 24-hour day.

d. Sulfuric acid (100 percent). 500 tons per 24-hour day.

e. Phosphoric acid (30 to 33 percent), 75 tons per 24-hour day.

f. Anhydrous ammonia (82.2 percent N), 150 tons per 24-hour day.

Ingredients Used

Ingredients used in production of anhydrous ammonia are natural gas, steam, water, and air. These materials are subjected to extreme pressures and temperatures to form anhydrous ammonia in a continuous process.

Part of this anhydrous ammonia is distributed as such for direct application to the soil. The remainder is used in manufacture of ammonium nitrate. This is treated in two different ways. Part is run through a platinum catalyst and oxidized to form nitric acid. The raw materials used are anhydrous ammonia, compressed air, and distilled water.

The process of manufacturing ammonium nitrate consists essentially of neutralizing nitric acid with additional quantities of anhydrous ammonia and dehydrating and pelletizing the resulting product. In this process the solution of ammonium nitrate resulting from neutralization is put through a vacuum evaporator where most of the water is removed. The concentrated solution is then sprayed from the top of a prilling tower 70 to 80 feet in height. The hot falling spray meets a countercurrent of air supplied by blowers at the base of the tower causing the droplets to solidify into small granules. These are dried, coated with an anticaking agent, and packed in moistureproof, multiwall paperbags.

Molten ammonium nitrate sprayed from shower heads at the top of these towers cools and solidifies into prills, shotlike particles, as it falls to the bottom. About 500 tons of ammonium nitrate fertilizer is prilled here daily by Mississippi Chemical Corp.'s plant at Yazoo City.

Transportation of Ingredients

Ingredients are transported to MCC's plant by pipeline or are obtained at the site. Movement from one section of the plant to another is also by pipeline and is controlled by automatic machinery.

The method of transportation from the plant to farmers and dealers in fiscal 1956 was as follows:

Method	Anhydrous ammonia	Ammonium nitrate
	Percent	*Percent*
Rail	31	79
Truck	69	21
Total	100	100

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Other Publications Available

Farmer Cooperatives in the United States, FCS Bulletin 1.

Methods of Financing Farmer Cooperatives, General Report 32. *H. H. Hulbert, Nelda Griffin and K. B. Gardner.*

Farmers Buy Supplies Cooperatively, Bulletin Reprint 3. *J. Warren Mather.*

Controlling Open Account Credit in Feed Cooperatives, FCS Circular 24. *Charlie B. Robbins and Lacey F. Rickey.*

Credit Control in Selected Retail Farm Supply Co-ops, General Report 35. *J. M. Bailey.*

Inventory Management by Selected Retail Farm Supply Co-ops, General Report 38. *J. M. Bailey.*

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Problems of Western Cooperatives in Obtaining and Distributing Fertilizer, General Report 11. *M. A. Abrahamsen and C. L. Scroggs.*

Farmers' Cooperative Fertilizer Manufacturing Plants (Facilities and Operations), Circular C–145. *E. G. Grab, W. M. Hurst, and C. L. Scroggs.*

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Fertilizer Distribution: Methods and Costs, Service Report 19. *M. A. Abrahamsen.*

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